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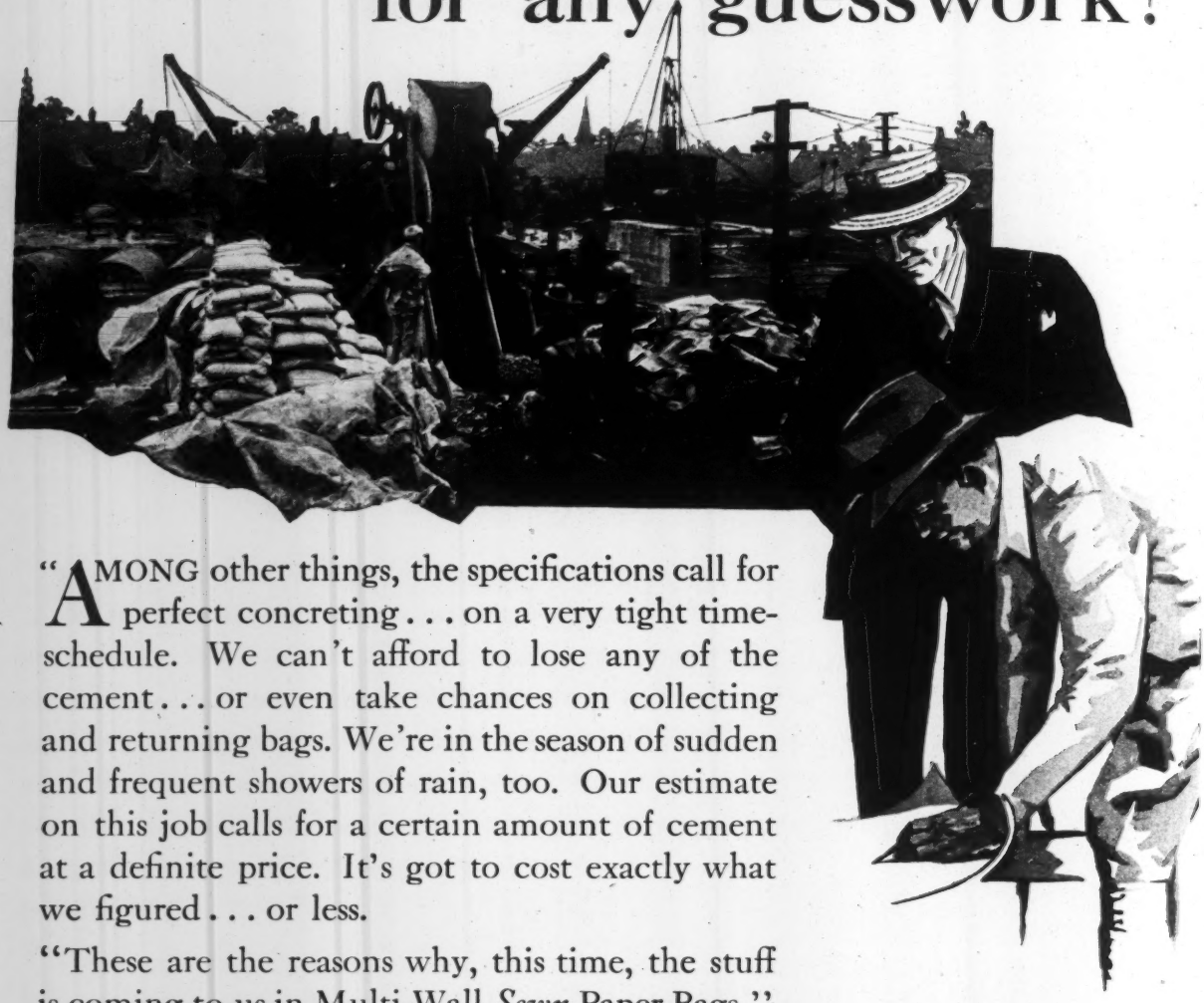

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Connecting Stockton With the Sea

San Joaquin River deepened and straightened to provide 26-ft. depth 44 miles above San Francisco Bay—Unusual levee construction used where immediate stability was required—Important Western river improvement described

By Captain W. A. Wood, Jr.
Corps of Engineers, United States Army

EXTENSIVE channel improvement under way on the lower 44 miles of the San Joaquin River, California, will provide a 26-ft. depth of water from San Francisco Bay to the city of Stockton. The project was reported on favorably by the War Department in 1925, and a $2,500,000 federal appropriation was made available in 1927; Stockton voted a $3,000,000 bond issue for its share of the program in 1930. The channel will augment present transportation facilities in the San Joaquin Valley in the handling of the large agricultural shipments as well as other products. River improvement consisting of dredging and levee construction has constituted the first phase of the work and is described in the following. The building of adequate terminal facilities at Stockton, by the city, is also in progress.

General—Draining to the north to join the Sacramento River at the upper end of San Francisco Bay, the San Joaquin River forms the lower half of the central valley of California. This valley is, in general, a flat alluvial plain about 400 miles long and 30 miles wide, of great agricultural importance. Many of the products raised form the bulk of the national production in their particular line. There are about 13,500,000 acres of agricultural land in the combined valleys under production, with an estimated annual value of more than $300,000,000. Manufacturing, although of lesser importance, amounts to $250,000,000 annually, according to the 1927 census report.

The valley is served by the Southern Pacific, Western Pacific and Santa Fe railroads, with main lines paralleling the major axis of the valley, supplemented by many branches. In addition, the

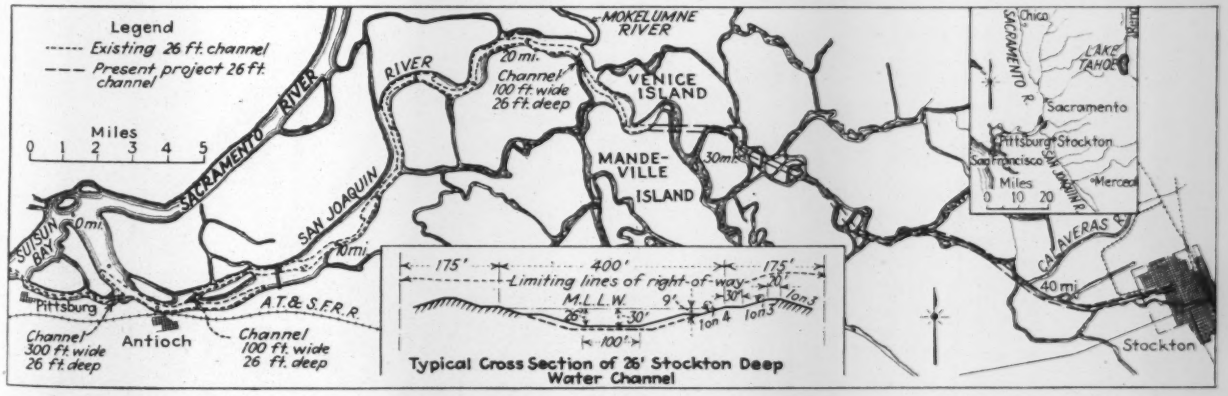


Fig. 1—Map of deep-water channel improvemenet of San Joaquin River to Stockton with typical cross-section of channel.

Fig. 2—Levee construction along new Stockton Shipway, showing the straight channel cut through winding section of the San Joaquin River.

area is traversed by a network of improved highways. Prior to the present work on the San Joaquin River it had a channel depth of 9 ft. to Stockton, with lesser depths above. The Sacramento River at present has a 10-ft. depth of channel to Sacramento, with lesser depths provided as far as Chico Landing.

In view of the large potential tonnage originating in the San Joaquin Valley and the possibilities of water transportation for much of the traffic originating tributary to Stockton, with substantial savings if direct ship transportation were provided above San Francisco Bay, Congress directed the War Department to make the necessary preliminary investigations and surveys on the feasibility of a deep channel. As a result of these surveys, the War Department in 1925 submitted a favorable report to Congress on a proposed project for a ship canal from Suisun Bay (the upper enlargement of San Francisco Bay) to Stockton. Authorization for construction of this project was incorporated in the river and harbor act of 1927, and ground was broken on the project April 14, 1930.

Channel

In general, the river improvement work consists of providing a channel in or near the San Joaquin River from deep water in Suisun Bay to Stockton, with a 26-ft. depth at low water and a 100-ft. bottom width. In addition, the project provides for a suitable turning basin near Stockton and a 9-ft. depth of channel 100 ft. wide in Mormon Slough to Center St. near the center of the business district in Stockton. The plan was subsequently modified to provide for a 26-ft. depth through Suisun Bay channel to the Carquinez Strait lower down in the bay. With completion of the channel, a 26-ft. depth of water will be available from the Pacific Ocean through San Francisco Bay to Stockton, about 90 miles above San Francisco. From Pittsburg, near the confluence of the San Joaquin and Sacramento rivers at the head of the bay, the channel follows the river about 24 miles upstream to Venice Island (Fig. 1), and from this point the channel is practically an artificial canal for the 17 miles to Stockton, although the course of the river is followed rather closely.

The total first cost of excavation and levee work is estimated at $2,890,000, with maintenance of $195,000 for the first year and $125,000 annually thereafter. In view of the large local benefit believed to accrue from this deep-water channel, the project provides that the city furnish, without cost to the United States, a suitable right-of-way 750 ft. wide for the channel, including the necessary width for the Mormon Slough channel, suitable areas for disposal of dredged material and $1,307,500 toward the first cost of dredging and levees. In addition to the above items, the project stipulates that local interests shall assume maintenance of the levees and shall complete, by the date of completion of the channel, terminals with berthing space of at least 1,200 lin.ft., having at least 800 lin.ft. provided with transit sheds, and that they acquire the necessary waterfront area and draft plans for an ultimate terminal development capable of handling at least 1,000,000 tons per year.

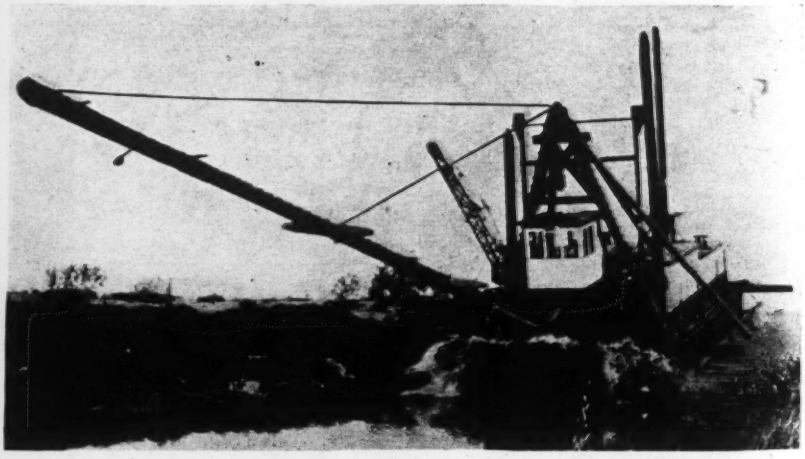
The typical cross-section of the deep-water channel (Fig. 1) indicates that provisions have been left for setting back the levees on both sides of the main channel by supplementary excavation. This would produce a greater channel surface width as well as allow for channel deepening, should traffic warrant such increase at a later date.

Levee construction

The levees were constructed by one of three methods: (1) dragline machines operating on land; (2) floating clamshell dredges; and (3) suction dredges. The majority of the levee work was done by clamshell dredges. Where these floating machines had insufficient reach, draglines were used, and at two sections where conditions were too unstable to permit placing the material on the bank in the usual manner the sand was pumped into place with suction dredges by a method described later.

Contract prices for levee construction amounted to 7.3c. per cubic yard for dragline work and varied from 6.6 to 9.3c. per cubic yard for clamshell operation. A 5½-mile length of levee was

Fig. 3—Sliding a 1-yd. clamshell dredge into a pool cut by a small dragline. From this pool the dredge cut a channel 90x15 ft. deep to be filled with sand for the levee.



constructed by dragline at a cost of $5,195 per mile; 12¾ miles was constructed by clamshell at about $26,750 per mile; and about 1⅓ miles of levee was built by combined clamshell and suction dredges for $113,500 per mile. The high cost of levee construction by clamshell as compared to that built by draglines was caused by the fact that practically all of the clamshell levees were built in peat formation, with subsequent shrinkage and settlement.

Fig. 4—Clamshell dredge shown in Fig. 3 cutting trench for sand fill along center line of proposed levee.

Fig. 5—The second step in building a stable levee was to pump in sand through a 20-in. pipe from a suction dredge.

The grade of the levee system varied from El. 20 (U. S. Engineer Department datum, Stockton) to El. 14.5, at a point 17 miles downstream at the lower end of the canal section. The total hydraulic dredging amounted to about 16,000,000 cu.yd. and varied from hard sticky blue clay at Stockton (contracted at 16c. per cubic yard) to soft unstable peat 17 miles downstream (7.25c.), and sand, clay and peat in the vicinity of the lower end near Pittsburg (9c.).

Sand levees

The channel traverses the delta area of the San Joaquin River, consisting of a network of sloughs, channels and islands. This land was originally a peat marsh over which the tide ebbed and flowed, but private interests have reclaimed much of the acreage by the construction of levees providing island farms. Cultivation of this land has caused it to settle until the interior elevation of some of the islands is as much as 6 ft. below mean low water. The material in the levees is mostly peat, and for this reason their construction has been effected at great difficulty. Should these levees fail, the delta farmers are subjected, not only to the usual flood damage, but also to the expense and difficulty of pumping the water from their land. The north levee of the cutoff channel across Venice Island (Fig. 1) and the south levee of the cutoff channel across Mandeville Island are of considerable importance for this reason.

In construction of these cutoff channels, therefore, it was not only necessary to make these levees stable and permanent but also to effect such stability immediately upon completion, in order that the cutting of the existing river levees blocking the cutoff channels at their ends would not be delayed. In order to meet these requirements a unique type of levee construction was adopted.

A small clamshell dredge operating a 1-yd. bucket on a 120-ft. boom was pulled over the existing levee and slid into a pool previously prepared by a dragline. This dredge then excavated a cut along the center line of the proposed new levee, 90 ft. wide and about 15 ft. deep, piling material on either side and forming two small peat levees some 40 ft. wide and 4 ft. high. A pile trestle was then constructed along the center line of this cut for carrying a 20-in. suction-dredge pipe line. In this pipe line 6x8-in. openings were provided at 8-ft. intervals. A suction dredge then began pumping sand into this cut from the river. By regulating the openings in the pipe line the sand fill was brought up gradually and uniformly along the line.

Although the work progressed satisfactorily with this method of construction, it was found, as had been anticipated, that during the process of raising the sand fill, it settled several feet in places, and the peat levees on either side were somewhat distorted both horizontally and vertically. When the sand fill was eventually brought up to grade and had reached a stable condition, it was topped with a layer of peat to reduce the effect of wave wash and wind erosion.

In carrying out the project it was necessary for the city of Stockton to acquire 250 parcels of land for the channel and disposal-area rights-of-way. Rather than require abstracts of title for each of these parcels, authority was procured for acceptance of these parcels under title-insurance policies. It is estimated that this procedure saved about two years in time that would have been required had it been necessary to secure abstracts of title in each case.

The majority of the work in connection with the deep-water channel is being performed under private contract, and it is estimated that the project will be completed during the latter part of the present year.

Walter B. Hogan, city manager of Stockton and former city engineer, has been active in the development of the project for years. B. C. Allin is director of the port. The channel work has been carried out under the direction of the district U. S. Engineer office at Sacramento.

Artificial Light Used for All Residual Chlorine Tests

The use of artificial light in making all residual chlorine determinations was recommended by C. D. Adams, chemist at the New Albany, Ind., filtration plant, in a paper presented recently at the meeting of the Indiana section of the American Water Works Association. Since the residual chlorine content of half the samples collected during the 24 hours must be determined by artificial light, the use of the same method for all samples will tend toward greater uniformity in technique. Any error produced will be constant. A small lighting unit consisting of daylight bulbs inclosed in an arrangement of mirrors or frosted glass, made so that the comparator can be placed within it, affords a good source of light for use in testing. It should be set up so that interference by daylight is avoided. Ordinary light bulbs give off yellow rays that interfere with the residual-chlorine test. Where no such lighting unit is available, daylight bulbs should be used in the room in which the tests are made. It should also be remembered that the color standards used will fade with age and should be checked at regular intervals and replaced when showing deterioration.

Highway Policies Defined for Metropolitan Chicago

Western Society of Engineers formulates thirteen rules of practice for highway development in the Chicago region

THE Western Society of Engineers in this report lays down thirteen policies which it asks all agencies controlling street and highway improvement to use as measuring sticks in the further development and use of the streets and highways in metropolitan Chicago. The time has long since passed when all roads are to be considered potentially ripe for improvement. Political pressure has determined the location of too great a mileage of highway improvement, and the society is driving toward the end of getting 100 per cent, instead of 70 to 80 per cent, of the surfaces laid where they will serve best.—EDITOR.

ONE of the grave problems of metropolitan or regional development is that of laying down principles or policies that should govern the development and use of streets and highways. The Western Society of Engineers, through its Civic Affairs Council, has had such principles and policies developed by a committee headed by Howard R. Olson, highway engineer of the Chicago Regional Planning Association. The following policies are believed to be desirable and are recommended to all street and highway jurisdictions:

1. Compulsory reporting to the state of accidents above a specified minimum severity and in a manner adequate for engineering and regulation use, copies of such reports to be furnished to local agencies for local use as well as copies of periodic summaries and studies.

2. Cooperative traffic studies by the state highway department and local agencies to secure data useful in planning street and highway improvements and traffic regulations.

3. In all improvements of streets and highways, plan for pedestrian traffic and its protection as well as for vehicular traffic, minimizing as much as possible the conflicts between the two. Possible ways to accomplish this result, where present and expected traffic and other facts justify the necessary expenditures, are as follows: (*a*) pedestrian grade-separations; (*b*) pedestrian crossing signals; (*c*) pedestrian ways along rural highways; (*d*) large blocks with interior playgrounds in new subdivisions, in resubdivisions and in reconstructed blighted area developments; (*e*) schools, churches and local business centers located away from major streets; (*f*) bypass routes for through-town highway traffic; (*g*) buses and trolley buses that load at the side of the roadway instead of street cars that load in the center; and (*h*) safety islands and raised dividing strips in wide pavements.

4. Improve and extend the use of automatic grade-crossing protection devices to all railroad grade-crossings shown by traffic and accident surveys to be important.

5. Continue building railroad grade-separations. As a general rule, separate first the grades of those existing and proposed crossings that rank highest on the basis of time to be saved and protection to be afforded per dollar of cost.

6. In the interest of expediting grade-separation work and improved protection, highway building agencies should assume a larger part of their cost.

[Due to Chicago's greatness as a railroad center the railroad grade-separation problem assumes greater proportions than in any other place in the world. At this time it appears out of the question to expect that in the near future grades can be separated at all principal railroad crossings. As population and motor-vehicle use grow, so will the mileage of highways and number of grade-crossings. Consequently, it seems most logical that the above policies should be followed in regard to grade-crossings of railroads and highways.]

7. Gather and use accident and traffic data in determining the proper layout, pavement design and regulation of traffic at street and highway intersections.

8. Continue building highway grade-separations to a limited extent. As a general rule, separate only those intersections that rank highest on the basis of traffic to be served per dollar of cost.

[In the case of grade-separations, careful consideration should be given to the needs of abutting property, to the operation of the street as a whole and to the limitations likely to control at other points not similarly treated. In the Chicago metropolitan area there has been created considerable public opinion in favor of the general construction of highway grade-separations on main thoroughfares, particularly on country highways where it seemed that such structures might be easily built. Experience has shown, however, that it is extremely difficult and costly to provide such structures. As a general rule, where separations are needed most the land values involved are so great that it is questionable whether the total cost is justifiable; and where they can be built at reasonable cost it is questionable whether the traffic justifies even the relatively small expense. Since there is considerable doubt as to the justification of such structures, a conservative policy should be followed until there is greater unanimity of opinion.]

9. Adoption of a state motor-vehicle code in substantial accord with the uniform acts prepared by the National Conference on Street and Highway Safety.

10. Adoption of municipal vehicle codes in accord with the model ordinance and sign and signal standards prepared by the National Conference on Street and Highway Safety.

11. Appointment or designation of engineering talent in each jurisdiction for handling the technical features of traffic regulation and control.

12. In planning new developments or improving those already established, make provision for public off-street parking facilities in business centers.

13. Limitation of the expenditure of money received from vehicle licenses and gas taxes to street and highway purposes and a major part to the needs of the principal thoroughfares.

Upper Potomac River Improved by Cooperative Effort

Complaints to the Maryland state board of health regarding the quality of water in the Potomac River above Cumberland led to the formation, in 1929, of the Upper Potomac River Board, composed of the city of Cumberland and of four large industrial concerns located along this part of the stream. Although it was recognized that the inflow of mine wastes and of sanitary sewage from towns on the watershed made it difficult to secure a high degree of purification, the board inaugurated a systematic study of the characteristics of the river water at seven stations along the river, established with the cooperation of the U. S. Geological Survey. The cost of this work the first year was practically $6,300, and it has since been carried on at an expense of about $1,200 per year to the manufacturers. The Geological Survey contributed about one-third of the original cost, as the gaging stations were built and equipped with automatic gauges directly under its supervision and control. The special board has adopted a five-year plan for carrying on this work, after which it is hoped that the state will continue the program. Guided by the results already obtained, the industries concerned have spent thousands of dollars to rectify the fluctuating conditions of the river and to make it usable in their plants, with the result that the condition or quality of the water has been materially improved and will continue to improve as further changes are effected.

Membership in the Upper Potomac River Board, aside from the city of Cumberland, include the following: West Virginia Pulp & Paper Co., Celanese Corporation of America, Kelly-Springfield Tire Co. and the Potomac Edison Co. Abel Wolman is chief engineer of the Maryland department of health.

Siphon-Spillway Models Tested Against Prototypes

Series of laboratory studies on siphon models indicates full-scale characteristics can be predicted—Data on priming and discharge—Conclusions on relation of models to prototype

By Herbert H. Wheaton
University of California, Berkeley, Calif.

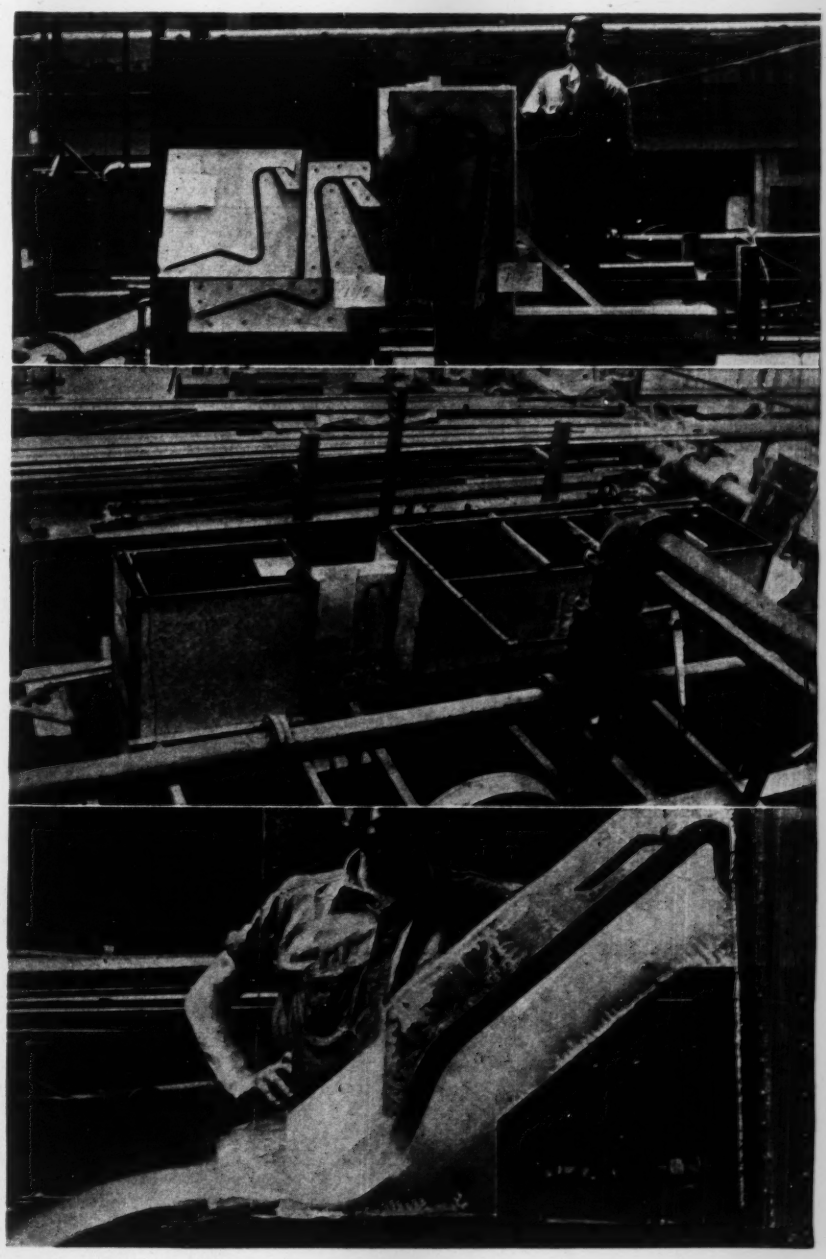
SUPPLEMENTING the data published recently on field tests of actual siphon-spillway installations (*ENR*, May 5, 1932, p. 649), the following article presents valuable material on laboratory studies of siphon models. Unusual significance attaches to these experiments because the models copied prototypes on which comprehensive field tests had been made. This permitted interpretation of results both as to reliability of tests and possibility of using models to determine operating characteristics of new installations. The following article, extending the material contained in the previous one, brings the subject of siphon spillways up to date. This valuable feature of hydraulic design, which has too long been subject to vague uncertainties, is receiving the attention required to make it available for more general and reliable use. The author recently was awarded the Freeman scholarship for hydraulic study abroad. —EDITOR.

FUNDAMENTAL relations between siphon-spillway models and prototypes and data on operating characteristics of both resulted from graduate research studies made in the hydraulic laboratory of the University of California. The original problem was to determine how completely a siphon model could be relied on to provide a true representation of the action of the prototype, and only siphons were selected that had been accurately field-tested. Extending the study, tests were made to determine the model-scale relation for coefficients and other factors not susceptible of field experiments.

Description of the Originals—The originals selected were tube No. 7 of the siphons at the Leaburg hydro-electric plant, city of Eugene, Ore., and tube No. 1 of the siphon in the Bear River feeder to the Tiger Creek flume of the Pacific Gas and Electric Co. on the Mokelumne River, Calif.

The Leaburg siphon has an outlet leg inclined backward toward the dam, and a water seal. The tube is rectangular in cross-section, uniform in width but varying in depth, with a throat area of 3.43 sq.ft. and an outlet area of 4.44 sq.ft. The difference in elevation between center of the outlet and the bottom of the throat is 28.9 ft. Priming occurred with a head of 0.2 ft. over the throat. The measured discharge was 119 sec.-ft., giving a coefficient of discharge of 0.62 based on outlet area.

The Bear River siphon has an outlet leg sloping away from the intake and was originally built without a water seal. A sealing basin was added later to insure priming. The siphon tube is of constant rectangular cross-section from throat to outlet, with an area of 12.5 sq.ft. It is equipped with a priming weir, which allows a screen of water to fall across the tube at a point just beyond the throat bend. With the water seal its maximum discharge was 312.6 sec.-ft. The difference in elevation between top of the outlet and the bottom of the throat is 25.7 ft. Priming occurred with a head of 0.2 ft. over the crest. The coefficient of discharge based upon outlet area was 0.61 with the water seal. This siphon and the



Use of three scales of models (upper view) confirms relation with prototype and provides data on effect of scale reduction. Built of treated sugar-pine lumber, the models were equipped with a glass side attached by shellac.

Set-up of model (center view) provided for measuring quantities of flow, heads, rate of rise and effect of air leakage on coefficient.

Lower view shows a typical test run of which hundreds were made to duplicate field tests on prototypes and to study additional problems.

tests made on it were described in detail in *Engineering News-Record*, May 5, 1932, p. 649.

Operation of models

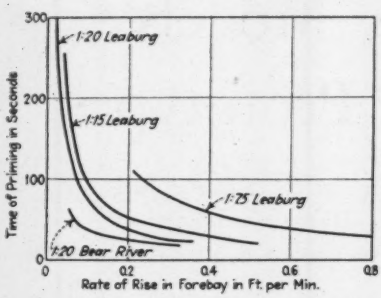
Models of the Leaburg siphon were built to scales of 1:20, 1:15 and 1:7.5, and the Bear River siphon was reproduced to scales of 1:20 and 1:10. The models were built of sugar-pine lumber treated with three or more coats of spar varnish and, except in one case, finished with white cement paint. Each model had one glass side attached to the wood with shellac.

With heads comparable to those during field tests, the Leaburg models showed consistently higher coefficients of discharge (see table) than did the prototype. Due to the large operating head, the diverging vertical leg of the prototype did not flow full, and it also sucked in some air at the air vent during field tests. Two models on the scale of 1:20, identical except that one was painted with cement paint, while the other had a smooth varnished surface, showed no difference in coefficient of discharge. One of the models, laid in a horizontal position and tested with the same range of operating heads as when in the vertical position, showed no noticeable difference in discharge. One of these models, when cut off at the bottom of the vertical leg, showed an increase in discharge coefficient from 0.685 to 0.705 for ordinary operating heads.

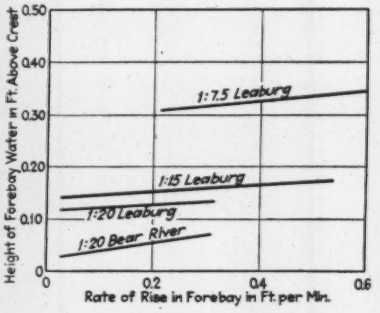
With the outlet submerged, the 1:20 model showed no decrease in discharge coefficient until the operating head was reduced to about two-thirds of that with free discharge. The 1:15 model showed no decrease until the head was reduced to about one-half of that with free discharge. Results indicate that the coefficient for the two model siphons began to decrease at about the same value of Reynolds' number, which is a figure expressing the relation of velocity times diameter divided by kinematic viscosity.

The Bear River model, 1:20 scale and with a water seal, showed a coefficient of 0.58. Without the water seal the model showed a coefficient of 0.59. With no water seal but with an obstruction in the outlet leg to facilitate priming, the coefficient was 0.58. With no water seal and with the priming weir intake blocked, the coefficient of discharge was also 0.58. Apparently the turbulence produced by the water entering from the priming weir during full flow is almost enough to offset the benefit of the larger entrance area that it provides.

Model Priming Tests — For each model of the Leaburg siphon the time of priming varied inversely as the rate of rise in the forebay. For the same rate of rise applied to all sizes the smallest siphon primed quickest. The ratio of the time of priming for any



Relation of rate of rise to time for priming models, showing effect of difference in the scale.



Effect of rate of rise on head to prime siphon models.

two models was directly proportional to the ratio of the first power of their linear dimensions, if the rate of rise in the forebay was the same. This is due, no doubt, to the compression of the air within the tube by the rising water in the forebay. With this compression the models all required forebay water levels above the top of the throat before priming occurred. When enough air was admitted to the throat through a rubber tube during the priming to maintain atmospheric pressure within the siphon until the evacuation of air commenced at the outlet, the time of priming was considerably shortened.

The head necessary to prime the Leaburg models was larger for rapid rates of rise in the forebay than for slow rates, although the actual variation in head for different rates of rise for any model was small. The curves of head required to prime plotted against the rate of rise of forebay water were approximately straight lines and were parallel for all three models. With the same rate of rise applied to all three sizes of model, the head to prime was directly proportional to the first power of the scale ratio.

A small rubber tube was admitted to the throat of the 1:7.5 model, so that atmospheric pressure was maintained within the siphon until the evacuation of air began at the outlet. This became so rapid that, in spite of the air sucked in through the tube, the siphon primed. Under these conditions priming occurred with less than one-third the head above the crest required when compression was present. With the compression thus relieved, the forebay water did not rise to the height of the top of the throat during the priming.

Comparing models and prototypes

The original Leaburg siphon primes more quickly and with a lower proportionate forebay elevation than did the models when compression was allowed. This was probably because of the air leakage in the original around the plate covering the air vent. Apparently no compression developed in the siphon, because air could escape during the rise of water in the inlet and for some time after first overflow. The leaks were small enough, as in the case of the model in which the throat was connected with the outside by a rubber tube, so that, after evacuation of air began at the outlet, air was carried out more rapidly than it could be supplied through the leaks. The model tests indicate that the original would have required a forebay water level above the top of the throat to prime the siphon had it not been for the leaks at the air vent.

This experiment also indicates that the submergence of outlet in the water seal should not be as great as in the Leaburg siphon. With less submergence less compression would be possible, and the models would prime more quickly and at lower heads. The tests point to the advisability of equipping a siphon that has a submerged outlet with a low-pressure air valve. Such a valve would eliminate compression in the tube and would close as soon as the pressure began to drop below atmospheric.

The time of priming could be reduced, perhaps at the expense of a decrease in the efficiency of the siphon, if the upper surface of the barrel at the lower end of the vertical leg curved more sharply. The air carried into the sealing basin by the water splashing down from above cannot pass around a large-radius curve and escape until the flow becomes considerable. With a sharp edge or small-radius curve, much air would escape when the flow is small.

Priming tests were made on models of the Bear River siphon under conditions similar to those imposed on the prototype (*ENR*, May 5, 1932, p. 649).

COMPARISON OF OPERATING CHARACTERISTICS OF SIPHON-SPILLWAY MODELS AND PROTOTYPES

	Coefficient of Discharge	Priming Head, Ft.	Time to Prime, Sec.	Per Cent of Air to Break Siphon
Rate of Rise = 0.3 ft. per min.				
Leaburg				
Prototype..	0.62*	0.2*	*	*
1:7.5 model	0.715	0.32	75	..
1:15 model.	0.695	0.16	40	7
1:20 model.	0.685	0.13	30	6
Bear River				
Prototype..	0.61	0.2	..	..
1:10 model.	0.61	....	..	..
1:20 model.	0.58	0.07	20	..

*Discharge and priming characteristics of original are not comparable to those of the models.

As the siphon was originally constructed the 1:20 model would not prime. It flowed full only as far as the priming weir, even with a considerable elevation of forebay water above the top of the throat. When the siphon was flowing full only as far as the priming weir, if the entrance of the channel leading to the weir were suddenly blocked, the remainder of the tube filled with water. When an obstruction was placed on the lower side of the outlet leg to represent the 2x8-in. plank across the leg of the original, the siphon primed. With a water seal that submerged the outlet somewhat more than that added to the original, but with no obstruction in the tube, the siphon primed. With a water seal identical with that of the original, the siphon would not prime. The sealing basin flushed clean, allowing air to back up the outlet leg before full priming occurred.

The 1:20 model primed more quickly for rapid rates of rise than for slow rates. At no time did the forebay water level rise to an elevation above the top of the throat. A change in the rate of rise in the forebay produced little change in the head required to prime. A comparison with tests on the original shows that a proportionately greater head was required to prime the model than the prototype.

The 1:20 and 1:15 models of the Leaburg siphon were each fitted with a tank to collect air as it escaped at the outlet. The 1:20 model required 6 per cent of air by volume at atmospheric pressure in proportion to the water passing through the tube to stop the flow of the siphon. It required about 3.3 per cent of air to reduce the coefficient of discharge of the model from 0.685 to 0.62, the coefficient obtained in field tests. The 1:15 model required 7 per cent of air to stop the flow, and 4 per cent to reduce the coefficient of discharge to 0.62. The quantity of air that leaked into the siphon around the air vent was undoubtedly not sufficient alone to account for the drop in coefficient of discharge below that of the model.

Conclusions

Although the tests are to be continued and all models have not been tested for all of their characteristics, the following tentative conclusions may be drawn:

1. The coefficient of discharge of a siphon can be determined from a model.

2. Small models show slightly smaller coefficients of discharge than large models. The original should show a higher coefficient than any of the models.

3. In siphons of the types tested the coefficient of discharge is constant throughout the range of operating heads usually required by field conditions.

4. The break in the curve of coefficient of discharge plotted against operating head seems to occur for models of the same siphon to several scales at a constant value of Reynolds' number. Model and original should therefore be compared only when both are above some critical value of Reynolds' number.

5. Models of the same siphon to several scales may show a correlation of results of tests of time and head to prime. Results of tests on one siphon need not necessarily apply to one of a different design.

6. The quantity of air necessary to stop the siphon may be determined by a model. It should give an indication of the necessary size of air vent. Results of tests for a particular design would probably not apply to another except in a general way.

7. The outlet of a siphon with a water seal should be submerged as little as possible, or compression resulting in the tube will cause an increase of both the time and head necessary for priming.

8. The value of a priming weir is questionable.

9. A sharp curve at the upper edge of the tube where it enters the water seal will facilitate quick priming.

10. A siphon, when flowing full, shows the same discharge characteristics as a short tube under the same operating head.

11. There is probably a limit to the scale reduction of the model for reliable results.

The research has been carried out as graduate thesis work in the college of civil engineering, University of California, by the author, assisted by Charles R. Sexton under the direction of B. A. Etcheverry, chairman of the department of irrigation engineering. Morrough P. O'Brien, associate professor of mechanical engineering, is in charge of work in the hydraulic laboratory.

Heavy Snow Load Sustained by Timber Roof Trusses

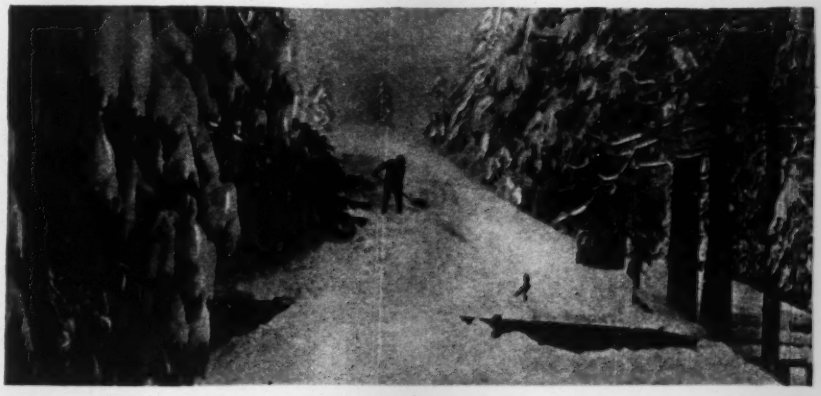
Accumulated load on building in Yosemite Park equals 156 lb. per sq.ft.—Stresses in roof doubled without damage—Deflections measured

By Thomas F. Chace
Consulting Engineer, San Francisco, Calif.

A SNOW LOAD of 156 lb. per sq.ft., which doubled the design stresses in timber roof trusses, was sustained during the past winter on a dining hall in Yosemite National Park, Calif. Snow is usually removed from the roofs of the buildings at Camp Curry, but during the near-record fall of the past season the three-year-old dining room had to be neglected to relieve older buildings that were occupied. An examination in the spring determined the weight of the snow pack and also checked the elements of the timber trusses for signs of distress. No damage was found in the framing, and the greatest deflection in the trusses was found to be 1¼ in. in a span of 28 ft.

The section of Yosemite Valley set apart for permanent camps lies at El. 4,000 ft. The surrounding sides of the valley rise precipitately to heights from 7,000 to 10,000 ft. within a few miles of the valley floor. A standard Weather Bureau rain gage has been installed at El. 3,983 on the sunny side of the valley, and a continuous record is available from the 1907-08 season.

Fig. 1—Removing accumulated pack of 8-ft. snow load, amounting to 156 lb. per sq.ft.



Mean annual precipitation at the station is about 33 in., including an annual snowfall of 108 in. Assuming the common rule of 10 in. of newly fallen snow equal to 1 in. of water, it is evident that about one-third of the precipitation occurs in the form of snow. Of course the density of snowfall varies greatly with varying conditions and, while it may be reasonable to assume the 1:10 ratio of water to snow depth in the valley, this ratio probably is nearer to 1:20 in the higher elevations. For the 1931-32 season, excluding May and June of 1932, precipitation equaled 38 in., including a snowfall of 168 in. This is the third heaviest snowfall on record at the station.

In the fall of 1928 a new dining room with a seating capacity of 800 was constructed near the upper end of the valley at the foot of Glacier Point, a peak that rises 3,200 ft. above the valley in a horizontal distance of less than half a mile. For long periods of time during the winter months the sun never strikes this structure because of the overshadowing cliffs.

The building is about 110x125 ft. in plan and is framed in wood, with foundations and floor of reinforced concrete. A diagram of the roof framing and details of a characteristic truss are shown in Fig. 2. This roof was designed for its dead load of 20 lb. per sq.ft. plus a live load of 60 lb. The live load was equivalent to a 5- to 6-ft. depth of new snow. According to the usual winter practice at the camp, it was the intention to remove snow whenever necessary, so that there would be no accumulation of load exceeding the design figures. However, owing to the severity of the last winter it was impossible to follow this program. The camp is unoccupied in the winter months, and there were not enough men available in the valley to remove the snow from the roofs of all buildings. Consequently it was necessary to let snow accumulate on the dining-hall roof, using all available men to save less secure structures.

As a result, a depth of 7 to 8 ft. of new and packed snow accumulated over the entire lower part of the roof. This load, including a deposit that had slid off the upper roof, was not removed until late in the spring. Because of the severity of the load and the length of time that it remained on the roof there was considerable interest in determining the amount of load, its effect on the structure and the probable excess stress induced in the trusses and other roof members. Observations made the end of March consisted of determining the weight of snow, checking floor levels and measuring truss deflections.

Before measuring the deflection a careful inspection was made of all important shear joints, bearings and connections in both the main and second roof trusses. No sign of slippage or failure was observed. After correcting for unevenness in the floor (maximum correction of ½ in.) the maximum apparent deflection in the roof trusses was observed and found to be 1¼ in. for a span of 28 ft. This is a ratio of 1:270, which was not serious, as the ceiling is of painted canvas. Some of the trusses had no apparent deflection.

Two snow samples were taken, one from the packed snow pushed off the lower roof and one from the snow packed in place on this roof. Both samples were carefully measured, after which they were melted down and the volume of water was determined. Measurements checked closely and indicated a specific gravity of about 0.50 for the packed snow, or a water content of almost 50 per cent.

On the basis of a load that included 3 ft. of newly fallen snow and 4½ ft. of packed snow (50 per cent water content) the load amounted to 16 plus 140 lb. per sq.ft. This load, combined with the dead load of 20 lb. per sq.ft., equals a total load of 176 lb., compared to the total assumed load of 80 lb. As a result, the stresses more than doubled the design assumptions and are represented as follows:

Character of Stress	Assumed Design	Probable Actual
End bearing	1,600	3,500
Bearing across grain	400	880
Parallel shear	150	330
Steel rods	16,000	35,000

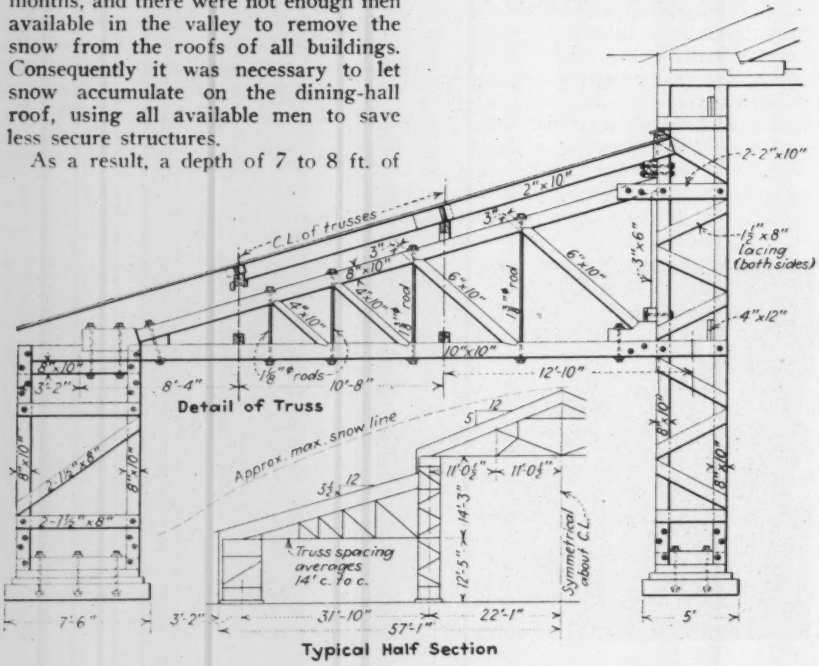
The material for the timber in the structure, purchased under special arrangement, was excellent No. 1 clear Douglas fir for all main trusses and column members. The excellence of the timber, combined with the method of executing the work by day labor under the direct supervision of the architect and structural engineer, were factors that saved the building from serious damage, as actual working stresses approached the ultimate more closely than is advisable under ordinary circumstances. A recurrence of similar load conditions will be prevented in the future by installation of a system of steam coils on the roof to melt the accumulation of snow. An example of a failure that did occur in a roof truss member in an older building under lighter load is shown in Fig. 3.

Fig. 3—Shear failure in roof truss member on another older building under lighter snow load.

As a result of investigating the excessive load and the condition of the timber trusses under this load, it can be concluded that the wooden roof framing behaved satisfactorily under abnormally severe conditions. All construction of this type, however, is open to the inherent problem of shrinkage. In the warm protected atmosphere under the roof sheathing this shrinkage loosens bolts and rods progressively as seasoning of the timber takes place. It is advisable to have the structural members tightened at least once a year, preferably late in the fall, under careful supervision.

Eldridge T. Spencer, San Francisco, was the architect, and the writer was consulting engineer.

Fig. 2—Sketch showing section of roof framing and details of roof truss.



Experience With Flooring in Industrial Buildings

Twenty-eight years' development of practice in light and heavy manufacturing at Hawthorne, Kearny and Point Breeze works

By O. C. Spurling
Engineer of Plant, Western Electric Co., New York

THE OBSERVATIONS made in the present discussion of floor surfaces and the conclusions drawn from these observations are a result of the writer's experience over the past 28 years, spent in close contact with the design and construction of buildings to house the manufacturing processes of the Western Electric Co. The majority of these processes may be classed as light manufacturing; in general these are housed in multi-story buildings. The heavy manufacturing, including cable-making, wire-drawing and some foundry work, has usually been housed in single-story buildings, with floors resting on fill or carried by pile-supported columns.

Maple floors at Hawthorne

The Hawthorne Works, on the outskirts of Chicago, came into existence in 1904 with the initial construction of single-story buildings for cable manufacture and rubber-working. Their floors, laid directly on dirt fill, consisted of 1⅛-in. T.&G. maple single flooring laid on 2x4-in. beveled pine nailing strips set 16 in. on centers in a 6-in. slab of plain 1:3:5 concrete (Fig. 2). A single layer of tarred felt with 6-in. lapped joints was laid between the maple and the strips. The use of this kind of floor was continued throughout two additions to the cable plant, constructed in 1905 and 1906, the machine shop, pattern-making and storage buildings of a power-apparatus manufacturing group and the first group of multi-story buildings for the manufacture of telephone apparatus, started some time in 1906.

A third addition to the cable-plant buildings was required about 1909. Dry rot having shown up in the flooring of the original cable buildings, a 6-in. layer of *asphaltic concrete* was placed on the dirt filling in this addition. Upon this stone was laid 2x6-in. rough yellow pine with steel tongues fitted into narrow grooves in the edges. The finish was 1⅛-in. T.&G. maple flooring. No nailing strips were used (Fig. 3).

The first addition to the multi-story group, built about 1908, used 1⅛-in. square-edge maple single flooring fastened to nailing strips by nails driven through the flooring with the heads countersunk. This flooring curled and was not as satisfactory a surface as the tongue-and-grooved maple.

Hawthorne was growing all the time as demands for telephone equipment steadily mounted, and year after year we added lateral buildings to the multi-story groups, usually in increments of 150,000 to 200,000 sq.ft. We first went to a double floor in multi-story space in 1910, using a ⅞x6-in. shortleaf yellow pine underflooring with ⅞-in. T.&G. maple top, as sketched in Fig. 6. Maple-flooring prices were rising at the time, and we saved by thus reducing the thickness.

A concrete ground floor

Meanwhile the flooring in the first and second additions to the cable-plant buildings had become unsatisfactory due to uneven settlement in the dirt fill and a wide spread of dry rot. In considering the type of replacement flooring we were attracted by a sample of plain (not reinforced) concrete roadway that was being introduced in Chicago by the Blome & Sinek Co. This concrete roadway consisted of a base of 1:3:5 limestone concrete 5½ in. thick, and a 2½-in. wearing surface of cement, sand and granite chips. The wearing surface was indented by markings of paving-brick size to provide a toehold for horses. We discussed with Blome & Sinek the use of this type of construction as flooring in our cable-plant buildings and had that company install a sample similar to the roadway paving, except that the wearing surface was 1½ in. thick and the markings were 9 in. square. We were so favorably impressed with the appearance of this floor that we installed it throughout the entire area of the cable-plant buildings. However, after covering about one-half the area we decided to omit the indentations in the top surface and leave the floor finish smooth. The construction is shown by Fig. 4.

This concrete floor in service failed in the main aisles, where a large amount of trucking was carried on, and we then experimented with surface hardeners. Sample slabs of concrete pavement about 3 ft. square were laid side by side to form a runway about 60 ft. long, over which a heavily loaded truck with iron wheels was pulled back and forth by automatic power equipment in an effort to determine the efficacy of the various types of hardening processes. We found that the plain concrete, using the granite-chips mixture for the wearing surface, stood up better than concrete pavement treated with any of the various hardening ingredients.

Features of various surfaces

Then followed experiments with magnesite flooring, asphalt mastic, asphalt paving blocks and creosoted wood-block paving 2 in. thick, to determine a satisfactory main-aisle finish. These

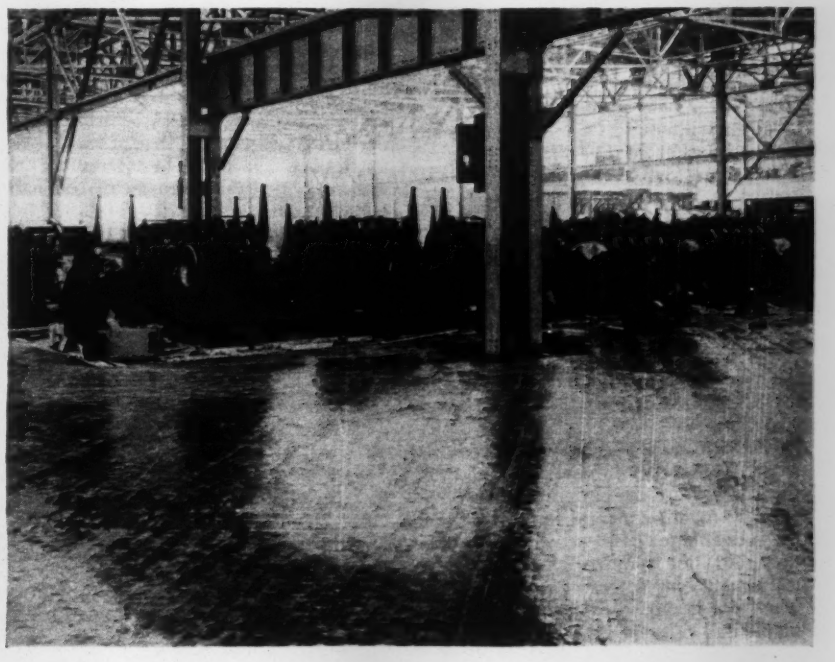


Fig. 1—A ground floor for heavy manufacturing or warehousing, as developed at Hawthorne and adopted at Kearny and Point Breeze. Creosoted wood block on concrete base is one of the types giving most satisfactory service.

Fig. 2

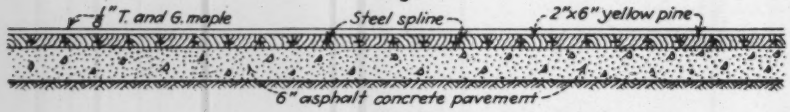


Fig. 3

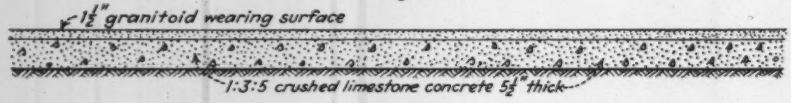


Fig. 4

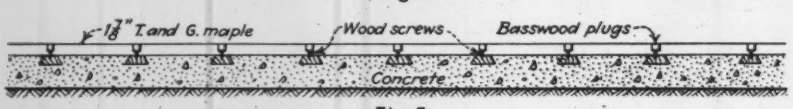


Fig. 5

Figs. 2-5—Four types of ground-floor construction. Early Hawthorne practice (1904), shown in Fig. 2, soon gave trouble through dry rot. Double flooring (Fig. 3) on asphaltic concrete (1909) was used to avoid dry-rot troubles. Two-course concrete with wearing surface containing granite chips (Fig. 4), which replaced the floor of Fig. 2 type in the Hawthorne cable-plant buildings in 1910. Heavy single-thickness maple on creosoted nailing strips, with under side of maple painted with waterproof paint (Fig. 5), proved a pronounced success in 1912.

trial installations led us to the following conclusions, which of course apply to the particular material in its stage of development at that time.

Magnesite on Concrete—Magnesite combinations laid on concrete foundations have proved all right for light duty but not better than 1⅛-in. T.&G. maple, and they did not stand up as well as smooth concrete under heavy trucking.

Asphalt on Concrete—Asphalt mastic laid in mass to a depth of about ¾ in. upon a concrete foundation was either too hard and cracked badly during the winter or was too soft and became spongy during the summertime. It collects dirt very readily and is very hard to clean without injury to it. It is injuriously affected by oil. It requires twice the effort to push trucks over it, as in the case of maple, magnesite combinations or concrete, and employees protested against its use.

Paving blocks made of hard asphalt mastic laid upon a concrete foundation were an improvement over the asphalt mastic laid in mass, in that the floor was free from cracking and sponginess, but the other objections found in the asphalt mastic applied against this type of construction.

Wood Blocks on Concrete—Creosoted wood blocks 6x3 in. in size and 2 in. thick, with 8-lb. impregnation, laid upon a smooth concrete foundation, had the advantage over wood strips that they did not require any special arrangement at intersections of aisles. The floor is not so easily cleaned as the maple and offers a little more resistance to the moving of trucks, although not enough to call forth protests from the workmen. It is a very satisfactory type of construction.

Heavy maple proves successful

In our multi-story buildings the dry rot soon began to show up in the first floors laid on dirt fill, and the wood flooring was replaced by concrete similar to that which had been used in the cable-plant buildings in 1911. On the upper floors we had difficulty in the main aisles due to breaking of the tongue-and-grooved portions of the maple flooring, and complaints were received of the roughness of the cross-aisles where the trucks ran across the maple flooring instead of lengthwise.

At the same time (about 1912) the condition of the concrete floor adjoining the oven rooms of the cable plant, where heavy trucking soon ruined the surface of the concrete flooring, convinced us that something other than concrete would have to be used in this area. Mr. Sinek felt that concrete had proved itself not suitable in this location and expressed the opinion, in which the writer concurred, that a very heavy maple floor was the best solution. It was suggested that creosoted wood nailing strips be used with 1⅛-in. T.&G. maple single flooring fastened to the nailing strips by countersunk wood screws. This we did, painting the under side of the maple flooring with a waterproof paint and driving basswood plugs into the countersunk holes above the wood screws. The resulting floor (Fig. 5) was a pronounced success, wearing very well and resisting dry rot.

Because of the satisfactory service obtained from this heavy maple flooring adjoining the oven rooms, we decided to try it out in the main aisles of the upper floors of our multi-story buildings in those areas where the double flooring had been used. Here the ⅞-in. maple top surface had not stood up well and was in bad condition. Power-driven circular saws were used to cut down through the double flooring in line with the edges of the main aisles, and a single thickness of maple flooring corresponding to the combined thickness of the ⅞-in. yellow pine and ⅞-in. maple was ordered; the two layers of flooring actually measured 1¹⁵⁄₁₆ in., and the heavy maple for the aisles was ordered 1¹⁵⁄₁₆ in. thick, tongue-and-grooved. As in the other case it was secured with wood screws countersunk and filled with basswood plugs. This heavy flooring was in all cases laid lengthwise of the aisle, so that trucks moved lengthwise of it except at aisle intersections. After being laid it was sanded by power-driven sanding machinery in order to obtain a smooth surface.

This type of construction (Fig. 7) has given perfect satisfaction in our main aisles. It is, of course, too expensive for use in the machinery and work-bench sections of the floors. Later multi-story construction at the Hawthorne Works used the double flooring described in the machinery and bench space and the 1¹⁵⁄₁₆-in. maple flooring in the main aisles.

Ground floors at Kearny

When the Kearny Works, Kearny, N. J., was started in 1923, the nature

Figs. 6 and 7—Double-floor construction (above), adopted for upper stories in 1910, proved highly successful except under trucking in main aisles. Final upper-story floor type (Fig. 7), with heavy maple in aisles, and maple on fir in working spaces (1913).

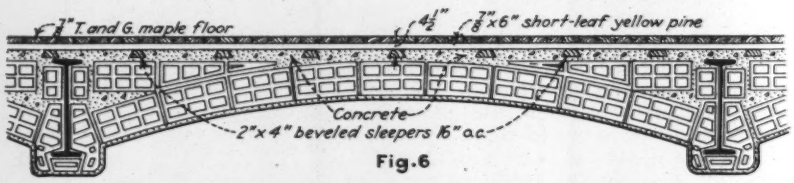


Fig. 6

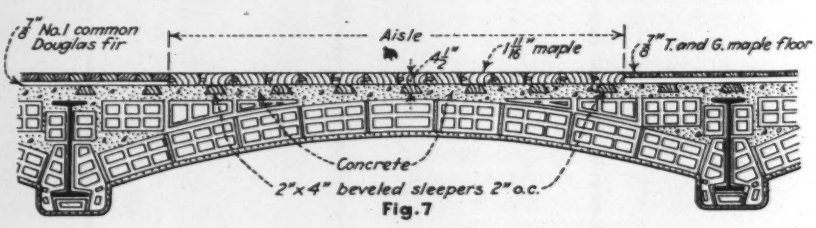


Fig. 7

of the ground led to the use of pile foundations and open basement areas under all buildings, so that the first-floor slab construction was carried on columns. Because of the uncertainty of the ultimate locations of main aisles, due to constant development in manufacturing machinery design, we abandoned the use of concrete surfaces in the single-story cable-plant buildings, and creosoted wood block was chosen for the entire area (Fig. 1). In the multi-story buildings the first floors were also covered with creosoted wood block, while the upper floors perpetuated the double floor and heavy maple aisle combination developed at Hawthorne (Fig. 7).

In the construction of warehouse buildings at the Hawthorne Works, concrete floors with surfaces laid by a patented method were used and were found to give reasonably satisfactory service at reasonable cost. This finish, as used by us, consisted of a 1:1:1¾ mix, the coarse aggregate consisting of granite chips. After spreading, the free water in the mixture was removed and the surface compacted by electrically operated floats followed by hand-troweling and curing. Later, when a merchandise storage and handling building was designed for the Kearny Works, we decided to make use of an integral metallic hardener in the top wearing surface of the concrete floors, and the results have been very satisfactory. This surface has withstood heavy trucking better than any other concrete floor finish that we have ever used.

Flooring on concrete slab

Prior to 1928 all of our multi-story buildings had been constructed of structural-steel framework and segmental-tile floor arches, with the nailing strips for the flooring embedded in a cinder-concrete fill. At that time, however, we decided to change this standard in favor of reinforced-concrete construction, and we became vitally interested in obtaining a satisfactory floor for general manufacturing purposes that would occupy a minimum thickness, since reinforced-concrete floor slabs do not readily permit the placing of nailing strips flush with their top surface. A wood surface was considered preferable from the standpoint of convenience in fastening machinery and benches in position, and also from the standpoint of the comfort and personal preference of our employees.

We considered, therefore, the use of 2-in. creosoted wood block, blocks laid end up, and other types of wood flooring. During this investigation we learned of the King wood-block flooring, made of maple about 1 in. thick, cemented to the concrete floor slab with a bituminous compound in a manner similar to the practice followed with creosoted wood-block paving. Trial installations of this product were made at our Hawthorne and Kearny works, with such satisfactory results that we decided to make use of this flooring in one of the first reinforced-concrete multi-story buildings to be constructed by us. Such a building had just been completed at our Hawthorne Works.

Fig. 8—At the Point Breeze Works, herringbone maple floor was laid in the insulated wire building in 1929. The pieces, 10x2½ in. and 1⅛ in. thick, beveled to interlock, are cemented to a primed floor slab with bituminous mastic and are finally sanded to level.

When the Point Breeze Works at Baltimore was started in 1929 with the construction of a cable plant, the same reasons that impelled us to use a creosoted wood-block floor finish in the cable-plant building at Kearny resulted in the selection of this type of flooring for the plant at Baltimore. However, in the insulated wire building that followed, it was decided to try out the King wood-block flooring on a large scale, and the entire area of this building (about 100,000 sq.ft.) was provided with this wearing surface (Fig. 8). This flooring has now been in service about eighteen months and has performed very satisfactorily.

Preparing the Concrete Slab—We have been generally successful in obtaining satisfactory concrete surfaces on which to lay wood blocks by specifying a smooth and level float finish with a maximum gradual variation of ¼ in. under a straight-edge 12 ft. long. This is less expensive than a trowel finish and provides a better bond with the block cementing material.

However, high-quality construction inspection is required under such a specification, since a poor float finish will often require expensive grinding to remove float marks, which, if they are permitted to remain, will cause blocks to split under traffic.

What experience has taught

Reviewing this experience, which covers a period of more than 25 years, the following conclusions have been arrived at:

Concrete floors with a satisfactory wearing surface, including an integral metallic hardener, can be produced at relatively low cost. The surface requires minimum tractive effort and is easily cleaned. It is, however, generally considered to be hard and cold where employees are for the greater part of the time standing, particularly if the slabs are laid directly on fill. A concrete floor gives a very solid foundation for high-speed machinery, but it is expensive to fasten the machinery in position. Tools and materials are damaged if they fall upon the floor.

Creosoted wood-block flooring laid upon a suitable concrete foundation is very satisfactory for heavy manufacturing, although it requires more tractive effort to pull trucks over it than concrete or maple. This type of construction is more expensive than a finish concrete.

A block floor is quiet but not convenient when high-speed machinery is to be installed. We have found it necessary to carry the holding-down bolts through the blocks and into the concrete foundation.

Maple surfaces are the most satisfactory for general light manufacturing operations. They permit ready fastening of machinery and benches in position by means of lag screws. For relatively heavy trucking in the main aisles the thinner sections of maple are not satisfactory, due to breaking of the tongue and groove. The square-edged maple is not satisfactory because of its tendency to curl. The 1¼-in. T.&G. maple held down by countersunk wood screws is perfectly satisfactory.

Asphalt mastic floors require a large amount of tractive effort to pull trucks over them, and it is extremely difficult—in fact, almost impossible—to lay this flooring from time to time with uniform hardness over all areas. The quality of the workmanship has a very great effect upon the quality of the product obtained. Materials left on it over night will sink into the flooring unless the mixture is so hard that the surface will crack up badly in cold weather.

Magnesite flooring depends upon the workmanship just as much as asphalt-mastic flooring, and our experience with it has been very erratic. A few installations have given very good service, but most of them have failed from cracking and pulverizing after a very short life.

King block floor is laid herring-bone fashion and does not give as smooth an aisle as the heavy maple laid lengthwise of the aisle, and we are somewhat concerned about the service that we shall get from this construction in our main aisles. Experience in the new multi-story buildings at Hawthorne will determine whether we will be satisfied with this flooring under heavy trucking in our main aisles.

Cotton Cloth Used to Waterproof Road Surface

Demonstration gravel-road surface with a cotton-cloth diaphragm as a water seal constructed by the Louisiana highway department

By Arnold Davis
Engineer in Charge of Construction, Baton Rouge, La.

ABOUT half a mile (2,650 ft.) of old gravel road near Baton Rouge, La., has recently been resurfaced with a diaphragm of asphalt-treated cotton cloth by the Louisiana highway department. The theory of the cloth diaphragm is to waterproof the material in the base and at the same time bind together the thin wearing coat of asphalt-treated gravel until it is thoroughly healed by traffic. The theory includes also, where necessary to shut off the rise of capillary water into the base, a second cloth diaphragm laid under the base. This second cloth seal was not used in the road built, which represents normal construction.

Inducement for the present trial of this construction lies in the large mileage of gravel roads that require stabilizing in Louisiana and other Central Southern states. These roads, built up by successive additions of gravel, consist normally of 3 to 4 in. of hard traffic-bound base with sometimes as much as 2½ in. on top of loose gravel from which all the natural binder has been blown away or whipped off the road by traffic. It was considered that, if a binder were added to the loose material and consolidated, and if penetration of surface water to soften the base were shut off, these roads could be stabilized at small cost. The cotton-fabric diaphragm described herein is a trial of a possible construction for this purpose.

Cotton fabric laid on asphalt base and covered with asphalt-treated surfacing forms watertight diaphragm protecting base.

The construction of the trial road was as follows: The existing loose material was bladed and shaped to a true cross-section. Emulsified asphalt was then applied and immediately mixed with a double-action disk and by blading. After the material was thoroughly coated (both fine and coarse aggregate), the mixture was spread out uniformly and allowed to set until the emulsion had broken. The material was then rolled and consolidated by means of a 10-ton roller. This consolidated base was opened to traffic for ten days to allow any weak or uncoated particles to develop.

The base was next swept clean, and emulsified asphalt was applied. Immediately following this application, a layer of fabric was placed on the surface. This fabric was laid before the emulsion had broken, which allowed the asphalt to pentrate into the interstices of the fabric. The top of the fabric was then given an application of emulsified asphalt to produce an absolute waterproof diaphragm.

Immediately following this application, the wearing-surface aggregate was spread on an average of 40 lb. of material per square yard. This surface was broomed and emulsified asphalt was applied. The wearing-surface aggregate was then rolled to a smooth surface, and after two weeks of traffic emulsified asphalt and sand were applied to fill in any small voids that traffic did not mesh in.

This road was constructed at a considerably lower cost than any surface treatment that has been laid in the Southern states. The materials used per square yard on the surface are as follows:

Emulsified asphalt, gal.	1.25
Fabric, sq.yd.	1
Wearing surface aggregate, lb.	40
Sand, lb.	5

Under the prevailing prices of labor and materials this type of pavement can be laid and completed for 32c. per square yard, including a fair profit to the contractor.

The road was constructed by Nelson Brothers, paving contractors, Baton Rouge, La. Construction methods used were under the writer's direction.

Acoustical Improvement in Louisville Auditorium

Work has been started on improving the acoustics of the million-dollar Memorial Auditorium Building in Louisville, Ky. Sound reverberation in the auditorium has been so severe that the building has been unsatisfactory for use. Among other corrections to be made, the large semi-circular dome is to be altered to have an elliptical shape. Sound reflections from the existing dome have been particularly bad. The walls will be built up higher, and the curvature of the dome will be reduced.

Concrete Superstructure Built on Old Timber Piling

Unusually low cost of $20 per linear foot for reconstruction of old trestle is made possible by closely spaced bents, permitting a simple short-span concrete deck slab

By Thomas D. Hunt
County Engineer, King County, Wash.

AT THE remarkably low cost of $20 per linear foot a trestle on the east shore of Lake Washington, near Seattle, was reconditioned by providing a concrete beam and slab superstructure over the old timber-pile foundation. The new deck has a 22-ft. roadway designed for standard 15-ton truck loading. Simplicity of design and use of the old piling made possible this reconstruction with funds at first considered inadequate for the work.

The bridge is located on the highway circling the lake at a crossing of swampy ground. A 30- to 40-ft. depth of black peat, indicating an old arm of the lake, is underlain with solid bottom of glacial deposit. In 1894 King County built an untreated wooden trestle at this site and in 1917-18 replaced it with another structure of the same type. Due to the much heavier traffic of recent years it became necessary to replace this second bridge. At first it was believed that limited funds would not permit the use of concrete, but the idea of cutting off the piles of the existing old trestle below permanent saturation and continuing to use them as a foundation made concrete economically feasible so long as the design was kept extremely simple.

The old trestle had been built with unusually close bent spacing—12½ ft. c. to c. The bents were of three piles, and no settlement had occurred in the fourteen-year life of the second bridge. Although quite badly decayed at ground level, the piles were in a perfect state of preservation only a foot or two below ground where permanent saturation exists. Therefore it was a simple matter to cut off the piles and incase their heads, and to build directly above them a new three-column bent of reinforced concrete. The new grade line, as formely, is close to the ground, and the new concrete columns are only a few feet in length.

With the 12½-ft. spacing, the one-way deck slab, continuous for eight bays, is only 8½ in. thick (Fig. 1). There are no longitudinal beams, and expansion joints 100 ft. apart are located at the bent over a widened cap beam. Cap beams cantilever 6 ft. 5 in. beyond the center of the outer column to furnish support for a 4½-ft. sidewalk of creosoted wood. Curbs are concrete, and railings are untreated wood and painted.

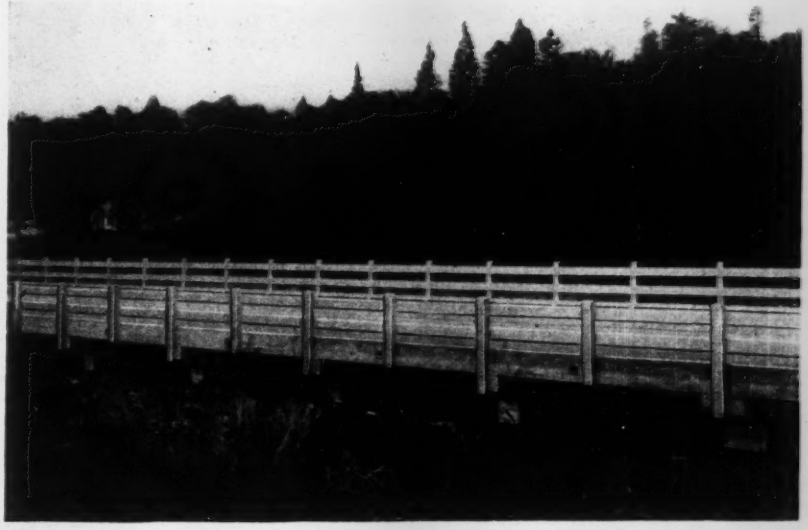
An important construction feature was the connection between the wooden pile and the concrete column. A square concrete section 2 ft. 4 in. in section and 2 ft. deep extends 12 in. above and below the pile cutoff. It was reinforced with ten turns of a ½-in. spiral, 2-in. pitch, and the vertical bars of the column above were stubbed into it. The column was 12x16 in. in section, and the wider top of the connecting block furnished an unyielding seat and support for formwork of the bent and the deck slab.

Bids were also taken on an alternate design, likewise supported on the cutoff piling of the old bridge, consisting of framed bents of creosoted wood, creosoted stringers and 2-in. roadway planking with a 5-in. reinforced-concrete slab, concrete curbs, creosoted sidewalk and untreated-wood hand-rails. On this design the low bid represented a saving of 7c. per linear foot, which did not seem to warrant its acceptance.

It would appear that a composite design of the general character used in the reconstruction might prove economical elsewhere under similar ground and foundation conditions. A close spacing of bents, making possible a simple short-span deck, can be had with newly driven piling quite as well as with old, which provides fully adequate foundation if proper bearing and permanent saturation are obtained.

The contract was executed by Gustafson and Olson, Seattle, on a bid of $34,490.69, or $19.71 per linear foot for the 1,750 ft. The writer was in charge of design and construction.

Fig. 2—Concrete superstructure with 22-ft. roadway built for cost of less than $20 per linear foot.



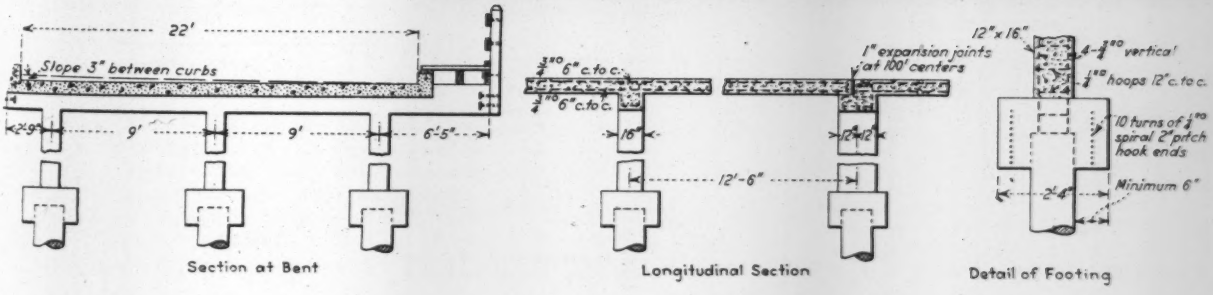


Fig. 1—Simple framing and use of sound old piles permitted economic rebuilding of trestle with concrete superstructure in which elimination of longitudinal beams simplified formwork and cut construction costs.

Uplift Pressure Measured at Gibson Dam

Observations show absence of uplift at construction joints and only nominal pressures at foundation levels—Foundation grouting effects

By Ivan E. Houk
Senior Engineer, Bureau of Reclamation, Denver, Colo.

TWO YEARS of uplift-pressure measurements at Gibson Dam show that appreciable water pressures from the reservoir do not permeate into the interior of the concrete; that only nominal upward pressures occur at the contact surface between the masonry and the rock; and that the foundation grouting near the upstream edge of the base, together with the installation of drains, is effective in preventing the transfer of dangerous water pressures from the reservoir to the rock formations.

Thus far, uplift-pressure measurements at the foundations of six masonry dams built on rock formations have been described or briefly mentioned in engineering literature. Similar measurements have been made at three additional dams, not including Gibson Dam, but the results have not been published. So far as the writer knows, the investigations at the horizontal construction joints in Gibson Dam constitute the first measurements of uplift pressure in the interior of a masonry dam.

General data

Gibson Dam is a concrete-arch structure, 195 ft. high at the maximum section, 87 ft. thick at the base, 15 ft. thick at the top and about 960 ft. long at the top. It has a vertical upstream face, curved on a uniform radius of 405 ft. Rock formations at the dam site consist of unusually regular beds of crystalline limestone containing frequent bedding planes and transverse fissures. Detailed description of design, foundation conditions, grouting operations, installation of drains, etc., were published in *Engineering News-Record* of June 18, 1931, in an article entitled "Design and Construction of Two New Reclamation Dams."

Three vertical shafts, 2x3 ft. in size, with the long dimensions parallel to and 12 ft. from the upstream face, are located in the north half of the dam for use in connection with experimental investigations (Fig. 1). Shaft 1, located near the crown section, reaches to a depth of 175.5 ft. below the top of the dam. Shaft 2, located about 113 ft. from shaft 1, reaches to the same depth. Shaft 3, located about 120 ft. from shaft 2, reaches to a depth of 141 ft. below the crest.

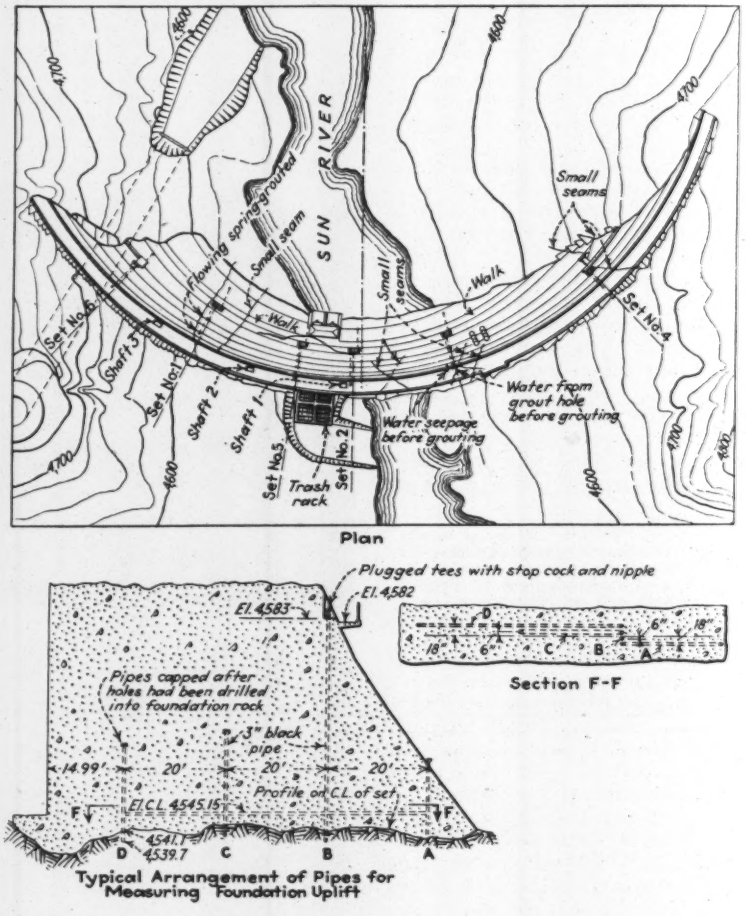
Construction of the dam was completed in the spring of 1929, and a small quantity of water was stored that summer. Radial construction joints were grouted in the spring of 1930, and the reservoir water surface reached the spillway level for the first time about June 1, 1930. Uplift-pressure measurements were begun May 12, 1930, and have been continued periodically since that time, observations being made about twice each month except during the coldest periods of the winter. All pipes were pumped out thoroughly, by means of a well bucket, about a week before the measurements were started.

Observations consist of measuring the pressures at the tops of the pipes with a carefully calibrated pressure gage in cases where the pipes are filled and actual pressures developed, and measuring the vertical distances from the tops of the pipes to the water surfaces with a sounding bell in cases where the pipes are only partly filled. The sounding bell consists of a piece of 1½-in. brass pipe, about 12 in. long, with the bottom open and the top closed, fastened to a metallic tape so that it can be conveniently lowered and the distances easily observed.

Installation of pipes at base

Twenty-four 3-in. pipes were installed at the base of the dam for the purpose of measuring uplift-pressure intensities at the foundation level. These were arranged in six lines of four pipes each, as shown in Fig. 1. Four lines were located in the central part of the dam where the foundation is below tailwater level, and one line near each end of the dam where the height of the structure is only about half as great as in the central portion. Pipes were placed from 10 to 20 ft. apart radially,

Fig. 1—Gibson Dam built with six sets of test pipes for measuring foundation uplift, and three shafts for measuring uplift at horizontal joints.



Typical Arrangement of Pipes for Measuring Foundation Uplift

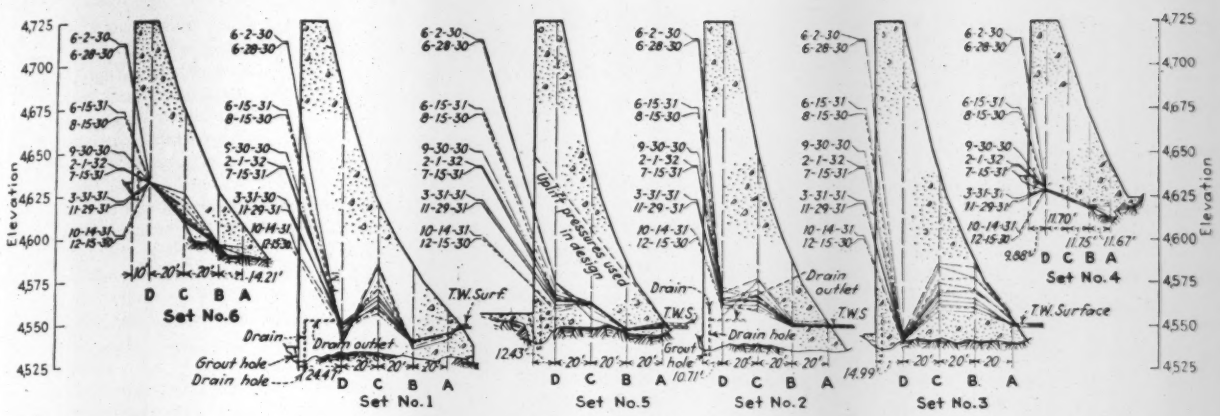


Fig. 2—Measured foundation uplift at Gibson Dam remained far below the half-pressure assumption used in designing.

the exact distances depending on foundation conditions and width of base of dam. Vertical pipe risers were placed at locations where uplift-pressure measurements were desired, just before pouring concrete in the base. Holes were later drilled through the pipes and 18 in. into the rock after the concrete was poured and after the grouting at the upstream edge of the foundation was completed. Elbows were then placed at the upper ends of the risers, and the pipes were run horizontally to locations beneath the sidewalk at the dowstream face of the dam, then vertically to the sidewalk level, where they were capped until measurements could be started.

Pipes in set 1 were placed parallel and adjacent to a radial seam in an old river channel. The seam was from ¼ to ¾ in. wide and was filled with a clay and gravel gouge. A warm spring, discharging from a confined opening in the seam at a rate of about 20 gal. a minute, was located within the base of the dam. The flow of the spring was stopped by pressure-grouting, 45 sacks of cement being forced into the opening. The rock near set 1 was sound and solid and contained comparatively few seams or cleavage planes except the one noted.

Pipes in set 2 were located in the bottom of the river channel where the rock was sound and solid. No grout could be forced into any of the grout holes along the upstream edge of the base in the vicinity of set 2. Set 3 was located at the foot of the south abutment, where the rock was somewhat more broken than at the other locations. Grout holes along the upstream face near set 3 took considerable quantities of grout. Some small seams existed in the foundation rock at the location of set 4, but none were found at the locations of sets 5 and 6.

Uplift at foundation levels

Representative results of the uplift-pressure measurements at foundation levels are shown in Fig. 2, a separate diagram being plotted for each set of pipes. Uplift pressures are shown as equivalent water surfaces, and the measured points are connected by straight lines. From the pressures observed at the pipes farthest upstream the curves are arbitrarily extended as straight lines to the reservoir water-surface elevations at the upstream edge of the base; also as straight lines from the pressures observed at the pipes farthest downstream to the tailwater elevations at the downstream face of the dam, except in the case of sets 4 and 6, where the base of the dam is above tailwater elevation. The latter extension of the curves is probably an accurate assumption. The former probably indicates uplift pressures greater than those actually existing, since the foundation rock was *thoroughly grouted along the upstream edge of the dam,* and since drain pipes were in all cases placed several feet upstream from the upstream measuring pipes.

In future uplift investigations it probably will be desirable to locate more measuring pipes near the upstream edge of the base. Probably one measuring pipe should be installed as close as possible to the upstream face of the dam, another at the location of the grout holes, and another at the actual location of the vertical foundation drains.

Measured uplifts very small

The diagrams in Fig. 2 show that the base of Gibson Dam is comparatively free from uplift pressure. This is undoubtedly due to the thorough grouting and draining of the foundation rock during the construction operations. The grouting and draining operations seem to be effective in preventing the development of dangerous uplift pressures at the base of the dam, but not 100 per cent effective in preventing reservoir water from permeating into the rock formations. At sets 1 and 3, and in some cases at sets 2 and 5, uplift pressures in the downstream half of the base were greater than at the upstream measuring pipes. This would seem to indicate the advisability of installing additional lines of foundation drains at locations farther downstream from the grouted area. As previously mentioned, set 1 was located near the radial seam in the foundation rock, and set 3 at a place where the rock was somewhat broken and where the grout holes took considerable grout.

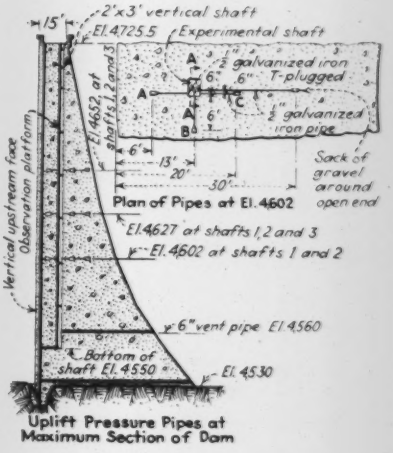

2'x3' vertical shaft
Experimental shaft
galvanized iron
T-plugged
galvanized iron pipe
Sack of gravel around open end
Plan of Pipes at El. 4602
El. 4627 at shafts 1, 2 and 3
El. 4602 at shafts 1 and 2
6" vent pipe El. 4560
Bottom of shaft El. 4550
El. 4530
Vertical upstream face Observation platform
Uplift Pressure Pipes at Maximum Section of Dam

Fig. 3—Pipes at horizontal joints at three levels gave means of measuring internal hydrostatic pressure within the structure of dam. Most pipes remained dry; only two showed any pressure (about 1 ft.).

Observed uplift pressures are less than 25 per cent of the total head in practically all cases. Since measurements have been made during water stages only a few feet lower than the maximum reservoir level, it is evident that the one-half uplift assumption used in designing the dam was entirely adequate. The design assumption was: uplift-pressure intensities varying as a straight line from full reservoir pressure at the upstream edge of the base to zero or tailwater pressure at the downstream edge, to be applied to one-half the horizontal area. This is equivalent to an assumption of uplift pressure on the full area varying as a straight line from one-half reservoir pressure to tailwater pressure. A line representing the latter pressure distribution is shown on the diagram for set 5 in Fig. 2. Of course the measured uplift pressures cannot act on more than 100 per cent of the area. As a matter

of fact, they probably act on a somewhat smaller proportion. For design purposes the maximum reservoir water surface was assumed to be at the top of the parapet wall, El. 4,729.

Thus far the measured uplift pressures during equal reservoir stages do not seem to have increased or decreased with time. In other words, no appreciable opening or tightening of the percolation passages through the foundation rock seem to have occurred during the two years of reservoir operation.

Pipes at construction joints

Thirty-two ½-in. galvanized-iron pipes were installed at horizontal construction joints for the purpose of measuring uplift-pressure intensities in the interior of the dam. Twelve pipes were located at shaft 1, twelve at shaft 2, and eight at shaft 3. The pipes were installed at different elevations, as shown in Fig 3, so as to measure the uplift-pressure intensities at distances of 6, 13, 20 and 30 ft. from the upstream face of the dam. The ends terminating in the concrete were inclosed in bags of gravel, so that water percolating through the concrete could enter the pipes easily. The ends terminating in the shafts were connected to vertical glass pipes, so that the heights of the accumulated water could be readily observed.

In constructing the dam the surfaces of the horizontal construction joints were thoroughly cleaned before placing fresh concrete. All laitance and loose materials were removed by brushing with stiff wire brushes, by the use of bars and picks and by washing with jets of water under high pressure. Just before placing new concrete, the surfaces of the joints were covered with cement grout spread to a depth of 1 in. and brushed into all parts of the joint with long-handled wire brushes. Horizontal construction joints were placed 4 ft. apart vertically and were provided with 9x18-in. keys parallel to the faces of the dam and 10 ft. apart.

Uplift at horizontal joints

Thus far no appreciable uplift pressures have been observed at any of the pipes installed at horizontal construction joints, even when the reservoir was filled to spillway level. In most cases the ends of the pipes have remained dry at all times. In a few instances they have been damp or wet; but at only two pipes has the water accumulated in the glass tubes to depths great enough to measure. At pipes *A* and *B*, El. 4,602 in shaft 1, depths of 0.5 and 1.3 ft., respectively, were observed on June 10, 1930, when the reservoir was first filled and when the reservoir surface was 2.3 ft. above the spillway crest, or 111.8 ft. above the level of the pipes. Pipes *A* and *B* terminate 6 and 13 ft. from the upstream face of the dam.

Since June, 1930, these measurements at the construction joints show that for the same reservoir stages the negligible pressures observed when the reservoir was first filled are gradually decreasing with time. In other words, the percolation passages at the joints, or within the concrete, are gradually being filled with lime deposits. It is interesting to note that no appreciable leakage occurred at any of the horizontal construction joints when the reservoir was first filled. A few wet spots could be noticed on cloudy days, but practically all of them disappeared on clear days.

The observations at Gibson Dam show that, so far as the concrete in the interior of the dam is concerned, uplift pressure could have been ignored in the design studies.

Uplift measurements at other dams

A search of engineering literature shows that in the case of masonry dams on rock foundations, uplift-pressure measurements were made at foundation levels at two dams in Germany and at four dams in the United States. These include the 131-ft. curved gravity Oester dam in Germany; the 100-ft. curved gravity Neye dam in Germany; the 166-ft. straight gravity Medina dam in Texas; the 70-ft. straight gravity Brule River dam in Wisconsin; the 70-ft. straight gravity Willwood dam in Wyoming; and the 80-ft. straight gravity American Falls dam in Idaho.* Unpublished uplift-pressure measurements were also made at foundation levels at the 112-ft. curved gravity Pit River No. 3 dam in California; the 200-ft. curved gravity Bull Run dam in Oregon; and the 140-ft. gravity tangent of the Ariel arch dam in Washington.

Appreciable uplift pressures, in most cases as great as or greater than the Gibson uplift pressures, were observed at all dams mentioned. However, the pressures were not of an undesirable intensity except in the case of Oester dam. Oester dam was built about 25 years ago, without grouting the foundation rock or installing foundation drains. Practically all of the measurements made at dams where the foundations were grouted and drained show comparatively low uplift pressures near the upstream edge of the base at the location of the grout and drain pipes.

The measurements of uplift pressure at existing dams show conclusively that, so far as foundation levels are concerned, uplift forces should never be ignored in designing straight or curved gravity dams where the entire water load, or the principal part of the water load, must be carried by gravity action, even though the plans may specify thorough grouting of the foundation rock along the upstream edge of the base and the installation of numerous drains at the foundation level.

Thus far, no satisfactory information has been secured regarding the proportion of the total horizontal base area on which the measured uplift pressures act. All that is known is that they cannot act on more than the full area. Taking the conservative position that the observed uplift pressures may act on the full base area, the results of the measurements thus far made at existing dams on rock foundations show that for design purposes the assumed uplift-pressure intensity curve should not be less than one-fourth uplift or more than two-thirds uplift. The expression "one-fourth uplift" is used to mean uplift-pressure intensities varying as a straight line from one-fourth of reservoir pressure at the upstream edge of the base to tailwater pressure at the downstream edge. The expression "two-thirds uplift" has a similar meaning. The uplift-pressure assumption used in designing the Gibson Dam, shown in Fig. 2, represents one-half uplift.

Since the measurements of existing dams invariably show comparatively low uplift pressures at the locations of the grout and drain pipes, the best assumption for design purposes probably is that the uplift pressure varies as a straight line from full reservoir pressure at the upstream edge of the base to some proportion of reservoir pressure at the location of the drains, then as a straight line to zero or tailwater pressure at the downstream edge of the base; and that these pressures are applied to the full horizontal area. The proportion of reservoir pressure assumed at the location of the drains should be varied in accordance with the character of the foundation rock. However, seldom if ever will it be necessary to place the value at more than one-half of reservoir pressure. A curve of this type, using one-half reservoir pressure at the location of the drains, was used in designing the just completed 405-ft. Owyhee dam in eastern Oregon. Such an assumption is usually equivalent to the two-thirds uplift assumption mentioned above.

Acknowledgments

The uplift-pressure investigations at Gibson Dam described herein were made under the direction of the writer. All Reclamation Bureau designing studies and investigations are made under the direction of J. L. Savage, chief designing engineer. All engineering and construction work of the bureau is under the general direction of R. F. Walter, chief engineer, with headquarters at Denver, Colo.; and all activities of the bureau are under the general charge of Dr. Elwood Mead, commissioner of reclamation, Washington, D. C.

*"Experiments on Uplift Pressure in Masonry Dams," by C. R. Weidner, *Engineering News*, July 31, 1913, p. 202.

"Percolation and Upward Pressure of Water," by W. A. Mitchell, *Prof. Memoirs*, Jan., Feb., 1915, p. 42.

"Tests of Water Pressures Under Brule River Dam" (*ENR*, Feb. 18, 1926, p. 274).

"New Design Features in Willwood Diversion Dam," by Ivan E. Houk (*ENR*, Oct. 27, 1927, p. 660).

"Upward Pressures Under Dams; Experiments by the United States Bureau of Reclamation," by Julian Hinds, *Trans.* Am.Soc.C.E., Vol. 93, 1929, p. 1,527.

Effect of Lead-Joint Heat on Bituminous Pipe Lining

No damage from overheating occurs during joint pouring if the temperature of the lead is not too high

By Elson T. Killam
Designing Engineer With Alexander Potter, Consulting Engineer, New York City

LEAD SUBSTITUTES for jointing materials have been used almost exclusively heretofore when laying cast-iron pipe lined with bituminous enamel. Occasions have arisen when the engineer designing the system has considered lead joints advisable, but doubts have frequently been entertained as to the ability of Bituminous enamel to stand up under the higher pouring temperatures involved. Because published data on this subject were not available, the author of the following article undertook the series of experiments that he describes so that specifications for a new pipe line might be properly drafted. —EDITOR.

TESTS to determine whether or not centrifugally applied Bituminous-enamel lining in cast-iron pipes is adversely affected by the heat of lead used as jointing material show that if the temperature of the lead is not materially above its melting point, no serious damage will be done.

The potential cause of damage to Bituminous-enamel lining when lead joints are used is the great difference in melting points of the two materials. Pure virgin lead has an average melting point of 625 deg. F. Bituminous enamel has no sharply determined melting point but has what might be termed a softening point, which is comparatively low, varying from 160 to 205 deg. F., depending upon the type of enamel.

Within the range of normal conditions covered by the tests, it has been concluded that it is entirely feasible to use lead joints with this type of lining material, provided that particular care is taken to control the lead temperature at the time of pouring and to limit this temperature to a working range considerably less than commonly occurs on most jobs.

The use of these two materials imposes two conflicting objectives on the person responsible for pouring the joints: first, to heat the lead to the highest feasible temperature to insure a full joint; and second, to keep the temperature as low as possible in order to avoid damage to the lining.

The tests that were made Sept. 26 and 28, 1931, demonstrate that within the range of test conditions and with the use of lead with a melting point of about 625 deg. F. a full and satisfactory joint can be obtained with a melting-pot temperature of 675 to 775 deg., and that the lining will not be damaged by lead poured at this temperature.

To obtain satisfactory results, the matter of temperature control requires more careful supervision than is often given to the common operation of joint pouring. It is believed, furthermore, that the different factors affecting the results are so variable and of such relative importance as to require considerable judgment on the part of the men pouring the joints.

Results that are entirely satisfactory are believed to depend on the judgment of the workmen in estimating the relative importance of the following factor: melting point of the lead, atmospheric conditions and air temperature, grade of enamel, size of pipe, depth of lead joint, class or thickness of pipe and the distance from the melting pot to the joint.

The melting point of lead in its commercial form varies somewhat, depending upon its purity, and accordingly is a factor to be considered in the matter under discussion. Pure virgin lead not only can be calked with greater facility but also has a lower melting point than remelted lead, for the latter commonly contains small amounts of other metals. The melting point of practically all metals often alloyed with lead is considerably higher than the melting point of pure lead.

Atmospheric conditions and air temperature have a major effect in determining the highest melting-pot temperature that can be used without resulting in damage to enamel lining. On a cloudy day the temperature of the pipe may have to be raised 150 deg. or more before the enamel-softening temperature is reached. On a hot summer day with bright sunlight the difference between pipe temperature and enamel-softening point before pouring the joints may be only one-half this amount, or even less. Recent tests show a comparatively rapid response of pipe temperatures to a change of air temperature,

TESTS TO DETERMINE EFFECT OF POURING LEAD JOINTS ON CAST-IRON PIPE LINED WITH BITUMASTIC ENAMEL

Size of Pipe, In.	Type of Enamel	Enamel Melting Point, Deg. F.	Depth of Lead Joint, In.	Temperature of Lead in Melting Pot, Deg. F.	Remarks Relative to Lead	Est. Temp. of Lead as Poured, Deg. F.	Remarks Relative to Bitumastic Lining
8	Regular	160–170	2½	715	Stick ½-in. square started smoking when held in lead	700	A few slight tears or drops developed, but enamel was not melted loose from pipe, nor did it drip. In no way was lining surface broken or pipe exposed
8	Regular	160–170	2½	865	Stick smoked heavily and lower end glowed red after 1-min. immersion in lead	860	Enamel over top 120 deg. of pipe, under point where lead hit outside of pipe, melted and dropped in stalactites forming solid drops adhering to invert. No solid sheet loosened, and no bare metal was exposed.
12	Regular	160–170	2½	710	.....	700	Enamel became softened and warm in top quadrant, so that indentation could be made with finger. No sag, tears or drip occurred, and upon breaking pipe no break was found in the lining, nor was any surface found bare.
10	XXH	195–205	2½	1000	Stick immersed smoked violently and burst into flame when withdrawn	1000	Lining dropped in sheet and hung down — loosened immediately over area of 25 sq.in.
10	XXH	195–205	2½	900	.....	900	Lining sagged and dropped loose from pipe. Not as large an area was affected as in last test.
10	XXH	195–205	2½	710	.....	700	No drip, tears or sheeting of lining. Slight wrinkling under pouring gate.
8	Regular	160–170	2½	815	Temperature of lead allowed to drop to 750 deg. at time of pouring	750	Slight drip but not as extensive as recorded for same size and type pipe — same grade enamel — and with pouring temperature at 860 deg.
8	Regular	160–170	2½	850	Allowed to cool to this temperature to determine lowest feasible temperature and yet obtain full joint.	675	Enamel showed more drops than in last test with 75 deg. higher temperature. Considerable drip but no sheeting or exposing of bare metal. Pipe when cut showed exceptionally thin wall. This was possible cause of undue effect on lining.

and on a clear day with strong sunlight the pipe temperatures may be 25 deg. F. or more above air temperatures.

The type of enamel to be used must necessarily be taken into consideration, for at the present time three types, each with a different softening point, are made to meet various temperature conditions. The XXH type enamel is manufactured and used for pipe that will be exposed to the sun during seasons when the air temperature is above 75 deg., and this enamel has a softening point varying between 195 and 205 deg. The regular type enamel is used for pipe that will be laid during seasons of moderate temperature. It has a softening point of 160 to 170 deg. When pipe is to be laid in freezing weather a flux is added to the regular type enamel to prevent its cracking, and the softening point of the resulting material depends upon the relative proportions of the materials used in combination. For ordinary winter conditions a softening point of 140 to 150 deg. may be considered average.

The size of the pipe must be considered because of the fact that damage to the enamel occurs primarily under the pouring gate and is centralized in a limited area on the interior and at the top of the spigot end of the pipe directly under the pouring gate. The period during which the hot lead is concentrated on the exterior of the pipe at the pouring gate obviously depends on the pipe size, and danger of excessive heating of the pipe and consequent damage to the enamel is much more likely to occur on large sizes.

The depth of the lead joint has some effect on results, in that the total area of hot lead in contact with the pipe wall and the duration of joint pouring vary with the joint depth.

The thickness of the pipe undoubtedly also has a bearing on the results. The probability of damage to the lining with high lead melting-pot temperatures is much greater with centrifugally cast pipe with comparatively thin walls than with ordinary pit-cast pipe with its thicker walls.

The distance from the melting pot to the joint has a slight effect upon the temperature, which should be maintained in the melting pot, but under average conditions no substantial temperature loss occurs if the pouring pot is kept hot. The consideration of this heat loss bears directly upon the question of the minimum temperature that can be used and yet insure a proper joint, rather than upon the question of damage to the enamel from excessively hot lead.

The pipe used in the tests was Warren Spun, class 150, centrifugal pipe, which has thicknesses of about 75 per cent of class B, A.W.W.A. pipe, and accordingly the effect of heat from the lead was undoubtedly greater in these tests than would occur with the thicker pipe. The lead used was best quality virgin lead, and the melting point was found to be slightly below 625 deg. F. Temperatures were measured with a steel-jacketed thermometer, built especially for recording temperatures of molten metals. On both days on which these tests were made the weather was cloudy, and accordingly the pipe temperatures were substantially the same as the temperature of the air, which was 70 deg. on the first day and 60 deg. on the second day.

The possibility of damage to the lining and the necessity for careful supervision in pouring joints is unquestionably a disadvantage of Bitumastic-enamel lining when lead joints are to be used, but the relative importance of such damage, or the additional care required to prevent damage, is not believed to represent sufficient grounds for not adopting the enamel, if it is otherwise deemed advisable. The damage, if allowed to occur, is confined in all cases to such a comparatively limited area that there is no material effect either in decreasing the carrying capacity of the line as a whole or in destroying the protective coating of the pipe. This latter observation is based on the fact that in no case was an area of bare pipe exposed, even with the highest test temperature. In all cases the area of enamel affected was limited to a small area directly under the pouring gate. Another factor that offsets the relative importance of such damage is that with pipe of comparatively large diameter, with which the greatest difficulty may be anticipated, it is a comparatively simple matter by working from the interior to make any necessary repairs to the lining.

The question of control of pouring temperature is of particular importance, and the test demonstrated the difficulty of judging the heat of the lead simply by noting its appearance.

During three months of the past winter 15 miles of pipe was laid, with enamel lining and joints of lead substitutes, in a water system being constructed under the supervision of the writer's firm. The heat of the jointing compound is so much lower than that of lead that no damage has occurred, and no special precautions have been found necessary.

Two Years' Operating Experience With Small Activated-Sludge Plant

By F. M. Veatch
With Black & Veatch, Consulting Engineers, Kansas City, Mo.

THE sewage-disposal plant at Ottawa, Kan., has now been in service for a little more than two years, and its record of operation offers some interesting data on small plants of the activated-sludge type. The cost of operating small activated-sludge plants is usually higher per million gallons than that of large plants, since the economies made possible by expert supervision are not available. However, the experience at Ottawa does show that sewage treatment by this method is satisfactory in small installations and that the cost is not prohibitive.

This plant (*ENR*, June 4, 1931, p. 927) was designed to meet a rather unusual set of conditions in that it had to be built close to developed city property and on land that is subject to frequent overflow. Furthermore, the sewage flow is subject to wide variation due to infiltration of groundwater and to occasional entrance of surface wash. It was estimated that an average flow of 1.2 m.g.d. would be received at the plant, but to date the average flow has been but 0.55 m.g.d., although the maximum has exceeded 2 m.g.d. In general, the plant has been operating at somewhat less than 50 per cent of its rated capacity. This low flow has influenced the operating cost, particularly as regards aeration.

The plant is operated by one man, who is in attendance from 8 a.m. to 5 p.m., but it is unattended during the remainder of the day. Extra labor is furnished as needed for sludge removal and other miscellaneous work. So far, extra labor has averaged twenty man-hours per month. The operator has no technical training but is able to make routine tests for solids in the aeration tanks, relative stability of the effluent and pH of the digesting sludge.

Plant has caused no odors

Results of the treatment have been good in that no complaints from odors have been received in spite of the fact that the plant is located within eight blocks of the center of the business district. Further, the periodic pollution of the receiving stream has been entirely eliminated. Below the plant the stream has been widely used for fishing, and the catches since the plant has been in operation have included many bass, crappie and channel catfish, whereas only carp, buffalo, bullheads and garfish were formely taken. For the year ending June 1 only five of the daily samples of the effluent were not stable (methylene blue test), and on each of these occasions the trouble was due to the bulking of the sludge by the discharge of waste buttermilk from the local creamery.

Since the plant has been in operation 40,000 cu.ft. of digested sludge has been dried on ½ acre of slightly sloping ground. No particular trouble has been

experienced in obtaining well-dried sludge, and it seems that the allowance of 3 sq.ft. per capita is sufficient. Standard sand beds for sludge drying were not provided in this instance due to the frequent flooding of the site, but for all practical purposes the sloping, undrained earth beds seem to be satisfactory. The requirements seem to be, first, a thoroughly digested sludge, and second, the application of the wet sludge in relatively thin layers.

Gas from sludge digestion is collected and used for heating the digestion tanks. For the past year gas production has averaged 5,480 cu.ft. per day, or about 0.6 cu.ft. per capita.

Air used higher than necessary

Power consumption for all purposes has averaged 194,900 kw.-hr. per year and is divided as follows: for sewage pumping, 46,776 kw.-hr.; for lighting, sludge pumping, clarifiers, digester, etc., 27,286 kw.-hr.; for aeration 120,838 kw.-hr. The power used for aeration amounts to 30.8 hp. per million gallons, a rather high figure that is due principally to the fact that all of the four aeration units are used continuously, whereas the average flow can be readily handled in two of them. The air requirement is therefore governed by the amount of liquid in the tanks rather than by the sewage flow. This method of operation has been adopted to minimize the effects of rapid increases in sewage flow and the occasional appearance of unusually large amounts of creamery wastes.

With careful laboratory control and continual attendance, the air consumption could undoubtedly be reduced materially, but the present scheme of operation is proving satisfactory, and the additional power, which is furnished by the municipally owned and operated plant in Ottawa, costs less than the additional attendance.

The yearly operating cost, exclusive of fixed charges, is as follows: labor $1,556; supplies $283; power $4,405. This represents a cost of $28.55 per million gallons of sewage treated and a yearly cost of 78c. per capita of the community served.

A great deal of attention has been paid to the appearance of the plant. The well-kept lawns and general appearance of cleanliness have done much toward building up the local popularity that the plant enjoys.

Letters to the Editor

Chinese Water Tank

Sir—The letter of M. R. Arick in the issue of July 21, 1932, p. 83, shows that Mr. Arick was not well informed. More than a year ago I heard an illustrated lecture by Mr. Murphy, the architect for Yenching University, and I understand from him that the water tank was housed in the pagoda that was already existing and that was designed by earlier Chinese architects.

Actually, Yenching University and Union Medical College were not designed solely by Mr. Murphy. I am sure that, without the help of his Chinese staff of architects, some of whom are American college graduates, those structures would not be as they are today. So in point of truth, this does make them "less American in design and construction." K. S. LEE.

New York, N. Y.,
July 24, 1932.

Cement-Water Ratio

Sir—In your issues of Nov. 31, 1931, and of Feb. 18, 1932, the articles by Prof. I. Lyse contain his method of the design of concrete mixtures based on three principles considered by the author as new ones: (1) substitution of cement-water ratio by weight for water-cement ratio by volume; (2) acceptance of the straight-line law for the relation between the strength of the concrete and the cement-water ratio; (3) assumption that the consistency of concrete mixes remains constant for the same aggregate and water content regardless of the richness of concrete.

Prof. H. Walsh, in the letter published in your issue of June 23, pointed out that the first two principles have been widely employed in Europe previously. I am ready to add that the whole method has its forerunners in the European literature. Lucien Vanderperre, the Belgian research worker in concrete, in his report "Le Dosage et la Préestimation des Bétons" (The First International Congress for Concrete and Reinforced Concrete) gave the method which is parallel to that of Professor Lyse in principles and proceeding. His paper included diagrams that make the procedure easy and fast. The first diagram gives the mixture of sand and coarse aggregate, depending on the maximum size of particles and the kind of materials. The second diagram fixes the water content, depending on the kind of mix and flow desired. Mr. Vanderperre incorporates for this diagram the same principle of constant consistency for a given aggregate and water ratio, regardless of richness of mix, as does Professor Lyse. Finally the third diagram shows the relation between the strength of concrete and the cement-water ratio by weight, also in coincidence with Professor Lyse. The great advantage of this method (as of several other European methods) consists in introducing the strength of the "normal" mortar as the base for the computation. Knowing this strength for the cement of a given brand (information which is provided and guaranteed by the manufacturer), the designer can determine the strength of concrete for any cement and for any age, without involved tests and merely by spending 5 min. in reading the three diagrams.

Resorting to the essentials of Professor Lyse's method, I will note that the very liberal application of the third principle meets some objection. In fact, the requirement of water changes with the richness of the concrete. Professor Durant conducted tests using variable amounts of cement for the same composition of aggregate and determining the exact quantities of water required to produce strictly the same flow of 170 ("Revue des Matériaux de Construction," 1930). The results were as follows:

Kind of Aggregate	Range of Cement and Water, Kg. per cu.m. of Concrete		Cement-Water Ratio	Per Cent of Increase in Water Dosage
	Cement	Water		
Porphyre broken stone and screening	236-452	246-263	0.96-1.72	7
Rhine gravel and sand	199-480	163-187	1.21-2.57	15
Porphyre stone and river sand	243-478	196-219	1.24-2.19	12
Meuse gravel and sand	244-379	163-189	1.50-2.01	19

This indicates that the water requirement may be raised 19 per cent even for a moderate increase of c/w from 1.5 to 2.0. Professor Lyse proceeds so far as to admit the constant water content for the change of c/w from 1.0 to 2.5.

On the basis of carefully conducted tests Professor Bolomey determined the quantity of water required for concrete as

$$W = N\Sigma \frac{aP}{d^{2/3}} + 0.23\,C$$

where aP = the weight of grain size d; P = the weight of the total aggregate; C = the weight of cement; N = coefficient depending on the consistency desired, the shape of grains, their surface, etc. ("Bulletin Technique de la Suisse Romande," 1931). For common mixes and conditions the factor $N\Sigma \frac{a}{d^{2/3}}$ is about 0.05 to 0.07. So the substitution of 1 lb. of cement for the corresponding volume of aggregate causes the increase in water required to about

$$0.23\text{-}0.06 \times 0.85 = 0.18 \text{ lb.}$$

In the extreme case of the change in c/w ratio from 1 to 2.5 (or in cement from 300 to 750 lb.) the requirement of water for the same consistency could rise from 300 to 381 lb., or by 27 per cent. It appears that the third principle of Professor Lyse's method should be restrained to moderate variation in c/w ratio. I. Rosov.

New York City,
July 14, 1932.

Book Reviews and Notes

A Monthly Commentary on Current Additions to the Civil Engineer's Library

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British Engineering Practice

ENGINEER'S YEAR BOOK FOR 1932—Originally compiled by H. R. Kempe and W. H. Smith. Revised under the direction of Lough Pendred, editor "The Engineer." 39th annual edition. Leather; 5x7 in.; pp. 3,039; illustrated. Published by Morgan Brothers, Ltd. London. Price 31s. 6d.

Extensive revisions have been made in those sections of this handbook that relate to steam power, electrical engineering, electric traction, internal combustion engines, automobiles, aeronautics, refrigeration, highway engineering and gearing, according to the publisher's statement. Minor revisions have been made in other sections. A detailed review of this annual publication was given in *Engineering News-Record*, Dec. 25, 1930, p. 1,019.

* * *

Structural Design Data

GRAPHS FOR ENGINEERS AND ARCHITECTS—By Donovan H. Lee. Cloth; 9x11 in.; pp. 88. Numerous illustrations. Published by E. & F. N. Spon, Ltd. London. $2.00 from Spon & Chamberlain, 120 Liberty St., New York, N. Y.

Simple graphs for the rapid design of structural work make up the bulk of this book. The author has purposely made them simple in order that the "architect may be able to anticipate the engineer's requirements regarding depths of beams, etc." Although prepared primarily for use in England, an effort has been made to render the book useful in this country and the Dominions. The London County Council building regulations are used. They call for 16,000 lb. on steel in tension and 600 lb. on concrete in compression. Data from American sources are included.

* * *

Taxation Systems

FEDERAL AND STATE TAX SYSTEMS: Third Edition [Jan. 1, 1932]—By the Tax Research Foundation. Prepared under the direction of New York State Tax Commission. Paper; 12x15 in.; pp. 145. Published by Commerce Clearing House, 205 W. Monroe St., Chicago.

By systematic tabular condensation the Tax Research Foundation here details one by one the taxation systems of our federal and state governments and of 23 foreign countries. It then does what every statistical compiler and editor of a mass of detail should do—summarizes the data. Among the summaries are tables on bank, gasoline, motor vehicle, property, public utility, sales taxes and on tax commissions and their powers. Eventually, the foundation hopes to cover all the countries of the world, a task made easier through having obtained the collaboration of the fiscal committee of the League of Nations. With taxation the pressing matter it is today, this compilation should contribute greatly to the understanding, simplification and just distribution of its burdens, even if it is assumed that the total load will be increased rather than reduced for years to come.

* * *

Government Officials

WHO'S WHO IN GOVERNMENT—Second Edition 1932-33 (Vol. II). Cloth; 7x9¾ in.; pp. 1307. Published by The Biographical Research Bureau, Inc., 460 W. 34th St., New York, N. Y. $10.

More than 7,000 names have been added to this listing of brief biological record of federal, state, county and city officials since the latest addition to the *Who's Who* directories first appeared two years ago. A valuable addition is a table of states with the principal state officials. Biographies are arranged alphabetically with a geographical cross-index by states.

* * *

Foreign Concrete Bridges

PUENTES DE FABRICA Y HORMIGON ARMADO—By Don Jose Eugenio Ribera. Cloth; 6x9 in.; pp. 368; many illustrations. Published by the author, Pinar 22, Madrid, Spain. 30.7 pesetas.

Written by the inspector general of roads, canals and bridges of Spain, this book gives a broad picture of reinforced-concrete bridge practice in Europe and briefly summarizes as well the design of such special structures as aqueducts and siphons. A chapter on the history of bridge decoration is included. The author has chosen for study many structures whose counterparts are for the most part unknown in the United States. Concrete trusses, through concrete girders, special articulated arches, even concrete suspension bridge, are included. Photographs and drawings are numerous and instructive. The book is No. 4 of a series but is complete in itself.

* * *

For Water-Plant Operators

WATER PURIFICATION CONTROL—By Edward S. Hopkins, principal sanitary chemist, bureau of water supply, Baltimore, Md. Cloth; 5x8 in.; pp. 131; numerous illustrations. Published by the Williams & Wilkins Co., Baltimore, Md. $2.

Operators of water-purification plants are specifically addressed in this pocket-size book written by the chemist of the Montebello filter plant at Baltimore. It is an attempt to assemble in non-technical form the basic facts of everyday filter-plant operation. The subject is covered in a series of chapters whose subjects follow the order of the flow through the plant. Coagulation is given lengthy attention, as is proper for a process whose control is so largely in the hands of the operator. As sedimentation basins are not usually subject to any material degree of manipulation after having been built, they are given scanty attention. Filtration and disinfection are treated at greater length.

Experiences gained in the Baltimore plant provide a large part of the data on which the chapters are based. Unfortunately, this fact produces somewhat narrow limits to the discussions, but for the purpose intended, the training of operators of small water plants, the book will serve well. There is no digression from the subject, and much of the information included has heretofore been available only in technical publications that are not likely to be handy to the small-plant operator.

Sewage Works Today

Reviewed by M. N. Baker
Upper Montclair, N. J.

MODERN SEWAGE TREATMENT—By T. P. Francis, engineer and surveyor, Dagenham Urban District Council, England. Cloth; 6x9¾ in.; pp. 322; numerous illustrations. Published by The Contractors' Record, Ltd., 329 High Holborn, W.C. 1, London, England.

BRITISH sewage-works design of today, with some notice of foreign practice, is concisely outlined in the first part of "Modern Sewage Treatment." Brief descriptions follow of plants recently built, or else rebuilt to current models, each contributed by the engineer or manager in charge. Appendixes deal with the theory of sewage treatment.

Mr. Francis begins with grit chambers, screens, oil tanks and sedimentation tanks, comprising means of preliminary treatment. He divides secondary treatment into two sections. The first includes land irrigation, land filtration, control beds and percolating filters; the second comprises "biological aeration," or the activated-sludge process. Sludge disposal is also described in two classes: (1) land, sea and dewatering; and (2) digestion. Stormwater and trade wastes, small plants and practice abroad (Germany, America and India) are next considered. This part ends with "a summary of the most recent proposals in sewage treatment and the conclusions to be drawn from recent experimental work."

Among the plants separately described in the middle portion of the book are those serving Birmingham, Rochdale, Bath, Dagenham, some seacoast towns and some wool-handling centers where large amounts of grease are recovered from sewage, notably at Bradford.

Subjects treated in the appendix cover sewage chemistry, hydrogen-ion concentration colloids, biology of sewage treatment, pumps and air compressors.

The book closes with sample examination questions and German equivalents for various sewage terms (by Dr. Max Pruss) and an index.

Most of the author's references to American practice deal with proprietary devices, especially those that have been introduced in England, where they are more widely favored than in America.

Finally, although "Modern Sewage Treatment" is designed for the eye and needs of British readers, it should be of interest and value in America and other countries as well. The illustrations are of universal appeal.

Reports on Home Building and Owning

HOME FINANCE AND TAXATION—Cloth; 6x9 in.; pp. 278. Published by the President's Conference on Home Building and Home Ownership, New Commerce Building, Washington, D. C.; $1.15 postpaid (foreign $1.25).

SLUMS, LARGE-SCALE HOUSING AND DECENTRALIZATION—Cloth; 6x9 in.; pp. 245. Published by the President's Conference on Home Building and Home Ownership, New Commerce Building, Washington, D. C.; $1.15 postpaid (foreign $1.25).

HOUSE DESIGN, CONSTRUCTION AND EQUIPMENT—Cloth; 6x9 in.; pp. 325. Published by the President's Conference on Home Building and Home Ownership, New Commerce Building, Washington, D. C.; $1.15 postpaid (foreign $1.25). Make checks payable to John M. Gries, executive secretary.

NEGRO HOUSING—Cloth; 6x9 in.; pp. 282. Published by the President's Conference on Home Building and Home Ownership, New Commerce Building, Washington, D. C. $1.15 postpaid. (Foreign $1.25.)

PUBLICATION of "House Design, Construction and Equipment" rounds out the set of eleven volumes planned by the President's Conference on Home Building and Home Ownership. A notable group of architects, engineers, town planners and real estate men have contributed to their compilation. The full set of eleven volumes ($10.50 postpaid) comprises the following: Planning for Residential Districts; Home Finance and Taxation; Slums, Large-Scale Housing and Decentralization; Home Ownership, Income and Types of Dwellings; House Design, Construction and Equipment; Negro Housing; Farm and Village Housing; Housing and the Community; Home Repair and Remodeling; Household Management and Kitchens; Homemaking; Housing Objectives and Program.

Of the four volumes listed above, the one on home finance and taxation lists the correct procedure as well as the pitfalls in the acquisition of a home, also the effect of taxation on home property. The hazards of second mortgages, foreclosure and special assessments are cited, and practical methods of buying are given.

The volume on slums and large-scale housing put successful handling of the problem right up to the business men of the country. Subsidation by the state, says Secretary Wilbur in the foreword, is sure to come if business dodges this challenge of slum rehabilitation. The most advanced thinking in this great social problem of the American city is recorded in the chapters of this book devoted to large-scale operations, financing and industrial decentralization.

The inadequacy of the living accommodations of our negro population of 12,000,000 is the subject of the volume on negro housing. Social and economic conditions force the negro population into the least desirable sections of our cities and into old and dilapidated houses, but despite the condition of these dwellings rents are higher than those paid by white people for similar quarters because there is usually a shortage of accommodations in the negro settlements.

Details of house design and construction are given in the third volume listed above. Plumbing, heating, electric wiring and refrigeration are included under the heading of equipment. Cost figures are given.

Miscellaneous Notes on Booklets and Reprints

MODEL TESTS ON HASTINGS DAM are described in Bulletin No. 2, University of Iowa Studies, University of Iowa, Iowa City, Iowa. (75c.) The studies were directed chiefly toward the elimination of erosion below the dam.

CONSOLIDATION OF MUD DEPOSITS is the subject of a reprint from the *Journal of Mathematics and Physics* (Vol. IX, No. 2, 1930). The reprint is an abstract from the doctor's thesis of Alberto Ortenblad. Its primary purpose is to develop data of value to those concerned with the construction of foundation on alluvial deposits.

FAULTY CONCRETE is the subject of Engineering Bulletin, Extension Series No. 27, Purdue University, Lafayette, Ind. The bulletin is entitled "How to Avoid Faulty Concrete in Small Structures." It is addressed chiefly to the small builder inexperienced in mixing and handling concrete. A set of specifications suitable for footings, piers and small walls is included.

"ZONING" is the title of a pamphlet published by the National Municipal League. The text, by Edward M. Bassett, council, zoning committee of New York, deals with the history of the zoning movement, reasons for zoning, experience in zoned cities, and legal pitfalls. Court decisions are cited in detail. A list of references to books and pamphlets on zoning is included, also to magazine articles. (National Municipal League, 309 East 34th St., New York, N. Y. 25c.)

BRIDGE AND STRUCTURAL PAPERS presented at the first Congress of the International Association for Bridge and Structural Engineering held at Paris last May are available in a preliminary report. Price 25 Swiss francs at the office of the Secretary, Prof. M. Ritter, L'Ecole Polytechnique, Zurich, Switzerland. There is also available a volume containing 39 additional papers contributed by the members of the association and discussed at the congress. The price of this volume also is 25 Swiss francs.

THE MODEL REGISTRATION LAW FOR ENGINEERS and land surveyors, prepared in 1929 by the committee on registration of engineers of the American Society of Civil Engineers and since revised a number of times by representatives of the major engineering societies and the National Council of State Board of Engineering Examiners, has been republished in pamphlet form to include the revisions adopted by the joint committee on revision, April 15, 1932. Copies may be obtained from the American Society of Civil Engineers, 33 W. 39th St. New York, N. Y.

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

EMERGENCY WORK RELIEF—By J. C. Colcord, W. C. Koplovitz, and R. H. Kurtz. Cloth; 6x9 in.; pp. 286. Published by the Russell Sage Foundation, New York, N. Y. $1.50.

STRESSES IN SIMPLE STRUCTURES—By L. C. Urquhart and C. E. O'Rourke, professor and assistant professor of Structural Engineering, respectively, Cornell University. Second edition. Cloth, 6x9 in.; pp. 333; numerous diagrams. Published by McGraw-Hill Book Co., New York and London. $3.50.

PRINCIPLES OF REINFORCED CONCRETE CONSTRUCTION—By F. E. Turneaure and E. R. Maurer, dean of the College of Engineering and professor of mechanics, respectively, University of Wisconsin. Fourth edition. Cloth 6x9 in.; pp. 461; numerous charts and line drawings. Published by John Wylie & Sons, New York and London. $4.

INDUSTRIAL MANAGEMENT IN THIS MACHINE AGE—By Francis A. Westbrook. Cloth; 6x9 in.; pp. 399. Illustrated with charts. Published by Thomas Y. Crowell Co., New York, N. Y. $3.50.

OUR WONDERLAND OF BUREAUCRACY—By James M. Beck, former solicitor general of the United States. Cloth; 6x9¼ in.; pp. 272; unillustrated. Published by The Macmillan Co., New York. N. Y. $3.00.

CAN WE ESCAPE?—By Guy Mallon. Paper; 5x7½, pp. 72; unillustrated. Privately printed by the author at The Ruter Press, Cincinnati, Ohio.

THE PORTS OF ASTORIA, LONGVIEW AND VANCOUVER, WASH.: Port Series No. 11, Part 2—Revised, 1931. Prepared by the Board of Engineers of Rivers and Harbors, U. S. Army, in cooperation with the Bureau of Operations, U. S. Shipping Board. Paper; 6x9 in.; pp. 166; many illustrations, including folding maps and tables.

Engineering News-Record

EDITOR—F. E. Schmitt. EDITORIAL STAFF—V. T. Boughton, W. G. Bowman, F. W. Herring, C. S. Hill, H. W. Richardson, W. W. De Berard, N. A. Bowers, J. I. Ballard.

Editorial and Publishing Offices at 330 West 42d St., New York; 520 North Michigan Ave., Chicago; 883 Mission St., San Francisco; Aldwych House, London, England.

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AUGUST 18, 1932 Volume 109 Number 7

Great Responsibility

UNUSUAL responsibility rests upon the members of the board of engineers appointed to pass upon the engineering adequacy of projects put up to the Reconstruction Finance Corporation for loans. It goes beyond the responsibility of the individual members as engineers in passing upon the technical details of the projects and reaches down to the fundamentals of the act itself. The effectiveness of the act depends largely upon how these five men approach their job. If they take a narrow view, discouraging all attempts to make constructive use of the relief act and giving adverse opinions on all projects except those that can show unquestioned ability to liquidate themselves, then the whole act may be doomed. But if they look upon their job as that of advisers not only to the financial directors of the R.F.C. but also to those who come to the corporation for aid, pointing out to them the faults of their proposals and recommending means of correcting them, then the construction provisions of the relief act can be made effective.

Housing Movements

PRACTICAL interest in large-scale housing projects for low-rental occupancy is visibly growing, as was to be expected from the stimulus given such development by the housing loan clause of the Relief Act and, indirectly, by the Home Loan Bank Act. Active plans for housing are under discussion in Cleveland, New York and other cities. Except in New York, legislation is still lacking, but there are fair prospects that several states will soon provide the necessary legislative basis for adequately regulated limited-profit housing construction. If present promises materialize we are likely to see actual trial of new ideas in house construction within a few years. The opportunities are large, though such plans as were recently published in these pages indicate that low rentals do not depend on wholly new forms of construction, and that probably the essential elements of shelter—walls, floors and roof—will undergo only moderate change if any. Better financing, refinement and coordination of planning, and improvement in construction processes may prove to be the main factors.

Accumulated Experience

ENGINEERING progress in this modern era rests on the solid foundation of highly developed theoretical knowledge, but today as fully as in earlier ages its superstructure is built almost wholly on practical experience. The test of time and actual use is superior to anticipation of performance, and records of the detailed results of service experience therefore have peculiar importance in our working literature. Especially does such experience accumulate in the continuous history of modern large industries, as in the case of the flooring experience recorded in this issue by O. C. Sperling. Many similar records of experience remain buried, with the result that a definite asset is lost to the working art. The present contribution is of value, therefore, not merely for the specific teachings on floor service that it records but also for the model it represents of unselfish report and analysis of experience. The present time, when every industry has occasion and leisure for review of its practice, would be well utilized if many experience records now buried could be brought to light.

Unfortunate Combinations

PROMPT rejection of the single bid for the contract to construct San Gabriel Dam No. 1, by the Los Angeles Flood Control District, was to be expected. The bid of $11,300,000 came from a new firm, Constructors, Inc., recently organized by ten contracting firms comprising most of the potential bidders for the job. The bid was $1,600,000 higher than the engineer's estimate—for apparently good reasons, not of moment here. On the face of the bidding, however, no prudent public official could have accepted the single bid. A combination of contractors to bid on an exceptionally large job such as Hoover Dam is not objectionable so long as the combination does not eliminate competition. When it does, however, the course of combination is being carried to a point where the suspicion of collusion is bound to enter the public mind. In the present case, retirement from the field of other prospective bidders at the last moment served to turn the spotlight on the combination. It may be that the segregation of the job into several separate contract items, now proposed, will eliminate the reasons for a pooling of contracting interests that necessarily has a monopolistic appearance. But at all events it would appear to be the joint duty of engineers and contractors to adjust their bid planning so as to preserve the reality of competitive bidding on which public-works contracting is based.

Care and Workmanship

ADDING another contribution of knowledge on dam uplift to our growing store, the Gibson Dam studies reported by I. E. Houk this week direct attention to the character of the assurance that is being acquired as to the safety of dams against underpressure. In most of the dams so far studied—a relatively small number—nothing like full hydrostatic pressure was measured either under the base or in the body of the structure. This removes many apprehensions that have been entertained by the more conservative. But it must be kept in mind that the dams that gave the favorable results were built with unusual care and excellent workmanship. The foundations were chosen after thorough examination for quality, grouting of the rock was done with meticulous care, and the concrete mass of the structure was dense material made with great precaution against the formation of seams and joints. Less carefully built structures may be subject to less favorable conditions of underpressure, and examination of any existing dam should take this possibility into account. But this is only the stronger reason for applying to any new dam the highest resources of the art. Otherwise the most unfavorable design assumptions are none too extreme.

Soil Research Pays Its Way

PROGRESS in the application of soil research to the practical uses of the designer and constructor exhibits a striking combination of confidence and doubt. This situation is particularly well expressed in the three discussions of soil bearing problems published last week. Some authorities hold that bearing tests have a a definite quantitative meaning, while others hold that much fuller study of soil physics is necessary before their true meaning can be known. With the experts thus disagreeing, the general practitioner may well believe that past and current soil investigations have little or no value to offer. But this conclusion would be premature.

Obviously, much more needs to be known than has yet been learned of the reaction of soils to foundation loads, and this is particularly true of the fine-grained plastic soils. Nevertheless, distinct progress is being made. As an example, the studies of clay in its undisturbed and its remolded states outlined by A. Casagrande are a distinct contribution to the understanding of this common material as a foundation support. Whether engineers must reverse their belief that piles floating in a bed of clay serve only to decrease its bearing power is not so vital a fact as is the proof that tests of the material in an undisturbed state give the only true index of its ability to carry load. Growing perception of this fact in current practice is expressed in the effort to develop the sampling tool (*ENR*, June 23, 1932, p. 891) to secure undisturbed clay samples at great depths below water surface for the Bay Bridge at San Francisco.

In such evidence lies the proof that soil research is paying its way in practical service to the foundation designer. It has progressed even farther in its service to roadbuilders, particularly in solving the long-standing difficulties presented by frost action. Soils present such complex problems for research to solve that knowledge naturally accumulates but slowly. Gradually the fund of information is building up, however, and we may look forward confidently to practical use as time goes on.

Personal Contact Restored

COMPLETE suspension of activities or drastic reduction in the staff of the engineering and construction subsidiaries of some of the large holding companies serves to emphasize the difficulty and disadvantages of maintaining a permanent centralized construction organization for a large group of public utilities. While the subsidiary companies are expanding rapidly the central construction unit is easy to maintain, but when business falls off the overhead of a central unit rapidly becomes a burden. The subsidiary companies always have enough engineering and construction work to warrant the maintenance of the nucleus of a small engineering staff; no such warrant exists in the holding company organization. Return of entire responsibility for the design and construction of new work to the local operating companies now is the order of the day.

Much opposition in the past has been expressed against remote control over engineering and construction in the power field. Possibly some justification for centralized control could be found when a large construction program was being carried out, but over against those possible savings had to be set the losses due to lack of close contract with the responsible head and to the lack of flexibility in the larger organizations. More important still from the standpoint of public relations was the elimination of personal contact.

Restoration of personal contact here as elsewhere in engineering work may be one of the benefits that will come out of the present depression. Herbert S. Crocker touched on this point in his address before the annual convention of the American Society of Civil Engineers. Who knows but that the ultimate gain to the individual engineer, through this reduction of centralized engineering work with its tendency toward too much specialization, may not more than offset immediate losses due to the general falling off in engineering works that the depression has brought?

A Call to Organize

GASOLINE-TAX diversion is the most serious menace that confronts highway finance and development. In 1932 the sum diverted to other than road uses will exceed $125,000,000. This is more than six times the amount diverted in 1931 and nearly one-fifth of the state gasoline-tax total. The $125,000,000 includes no part of the new federal tax recently imposed for budget-balancing purposes. Nor does it count the possibilities of additional diversion by legislatures now sitting in relief sessions—and some of these possibilities are large. It exceeds regular federal aid to states for roadbuilding and nullifies the emergency fund of $120,000,000 provided for unemployment relief.

This, briefly, is the present situation. What further possibilities does the future hold? Finding their opportunity in the current depression, those elements of government that have been seeking escape from direct-tax increases by gradual filching have in 1932 conducted a major raid on the tax levies for highway service. In a dozen states, since New Year's, the attacks of these interests have been foiled only by a small margin, through resort to ingeniously devised measures for avoiding direct taxes, as, for example, the sales tax in Mississippi. But the influences working for diversion in these states are not dead. Encouraged by the signal success of the steals accomplished, these influences will attempt further depredations as legislatures struggle with the relief problems of the coming winter.

The outlook before highway officials is not only further diversion but the more dangerous contingency of a complete breaking down of the principle that the gasoline tax is a toll paid by the road user for service, and that road expenditure holds a first lien on the money. Once this principle is broken down, the federal government may well doubt whether it should continue to donate money to replace funds which the states are diverting from their road income. Such a contingency is well within the reckoning.

Defense against diversion has not yet organized. Moreover, it lacks definite weapons, for today there is no balance sheet of the highway business, no budget of future road needs and earnings and no statement of the road mileage of which diversion has deprived the road user. The forces urgently need to be coordinated. Every group is fighting in its own interest and not directly in the interest of road service to the public. The situation is a bitter travesty on public-roads business management. Unless highway engineering can display greater capacity it deserves to forfeit federal aid and the high imposts that the road user has cheerfully accepted to increase highway service.

NEWS OF THE WEEK

Public Work Funds Cut $44,000,000 By the Economy Act

Washington Correspondence

ABOUT $44,000,000 may be lopped off this year's $700,000,000 federal public works program by the provision of the economy law requiring that 10 per cent must be deducted from the limit of cost fixed on all previously-authorized projects that were not under contract June 30. The cut applies not only to construction work carried in the regular departmental appropriations but also to the public works embraced by the Emergency Relief and Construction Act to the extent that such projects had been previously authorized.

Excluding federal-aid road construction that seems to be definitely exempt from the 10 per cent cut, the estimated total of construction carried by the regular supply bills for the fiscal year commencing July 1 last is $268,498,767. Barring work under contract on that date and other exemptions that may subsequently be made, the reduction would cut off $26,800,000. The relief act carries $322,224,000 for public works but as the 10 per cent cut applies only to previously authorized work that, roughly, totals $171,914,000, the reduction is $17,000,000.

The 10 per cent provision threatens seriously to hamper the construction program as current bids on federal jobs reveal that contractors anticipate a rise in costs during the coming year. Many bids exceed the original authorized limits and a 10 per cent cut will, in many cases, delay work for months and may possibly force abandonment until Congress comes to the rescue.

Fortunately, much work that is now under way will not be interrupted as the Treasury Department has obtained a ruling from the Comptroller General which includes under the exemption projects already contracted for and buildings on which plans and specifications had been completed, and contracts for foundation work let prior to June 30. There are 12 major buildings in this class, including the post offices at Philadelphia, New York, Norfolk and Albany.

To expedite work and provide employment the Treasury Department had divided the jobs by first contracting for placing the foundation work. A 10 per cent reduction from the original authorizations would cut the balance by $5,052,000. To throw the whole burden of this reduction on the superstructures, for which the drawings and specifications have been completed, would, according to officials of the Treasury Department, necessitate holding the work from the market and require redesigning to an extent that economies intended by Congress would be absorbed in additional architects' fees and continued payment of rents for leased quarters.

As the 10 per cent cut applies to the cost limits fixed in all previously authorized projects, whether an appropriation therefor has or has not been made, the application of this provision is not confined to work contracted for during the current fiscal year, but to authorized work planned for ensuing years. A notice to this effect has been sent to all federal construction agencies by the Federal Employment Stabilization Board with reference to its bearing on the six-year advance plan that the construction agencies are required to prepare under the Wagner stabilization law.

Relief Fund to Be Used for Road Contracts Already Let

Application of the highway funds made available by the Emergency Relief Act to the payment of work carried out under existing contracts has been authorized by the Bureau of Public Roads. It is expected that this authorization by the bureau will permit the restart of work which has been held up in many parts of the country due to lack of funds, provided that the contractors agree to the more stringent limitations on the use of labor saving machinery set up under the relief act.

High Water Found Justification For Delay in Contract Work

Abnormal high water was recognized as adequate justification for failure to complete a contract at the specified time by a federal court sitting recently at Jamestown, N. Y. The court awarded Fred W. Bond, a contractor from Lockport, N. Y., a verdict of $2,285 against the United States Government on a counter-claim in a suit brought by the government to collect $11,500 for alleged default on a contract to build the superstructure over the west pier at Olcott Harbor.

The contractor maintained that inaccurate specifications furnished for the job by the government and an "act of God" which caused the rising of water level in the lake to be above normal prevented him from completing his work on time. A miniature working model of the pier was introduced as evidence to prove that the unusual high water which existed in Lake Ontario in 1929 was of a character to interfere with the progress of the work.

R.F.C. Loans Desired For Many Public-Works Projects

AN INCREASING number of construction projects for which loans from the Reconstruction Finance Corporation are contemplated appears this week. Supplementing the list of projects published in *ENR*, July 28, 1932, p. 117, Aug. 4, 1932, p. 142 and Aug. 11, 1932, p. 176, the following developments have become matters of record:

A conference has been held by Senator Wagner, New York, with the officers of the Reconstruction Finance Corp., at which discussion was given to a proposed loan of $26,000,000 for the completion of the Triborough bridge in New York City. Formal application for the loan has not yet been made.

Bridge work to stop

It has been stated that unless money is made available, work on the bridge will have to be discontinued within the next few months. Already the city has spent between five and six million dollars on the bridge, the total cost of which has been estimated at $32,000,000. The bridge project was eliminated from the New York municipal program as part of the city's economy plan.

Decision has been made by the city of Seattle, Wash., to apply to the R.F.C. for a loan of $7,500,000 for extensions and improvements to the municipal power system. The money is planned to be used for the extension of the power distribution system within the city limits and to finish the Diablo plant on the Skagit River.

The project calls for the completion of the new power house at Diablo and the installation of generating machinery, construction of a concrete apron at the Diablo dam, a new transmission line from Diablo to the Gorge Creek power house, a transmission line from there to Seattle, and extensive purchases and improvements for the system in Seattle. The application as now designed contemplates the use of $493,000 to build two additional stories on the city light tower, $394,000 to complete the purchase from the Puget Sound Power & Light Co. of power stations used by the municipal street railway, and $500,000 for an addition to the south receiving station. Extensions to the distributing system would require $1,000,000, the Skagit-Seattle transmission line would require $2,804,000, and $2,495,000 would be used for the construction and machinery installation at the Diablo plant.

An additional list of municipal construction projects for Seattle has been compiled by M. O. Sylliassen, city engineer. The city is attempting to borrow $6,000,000 for the program.

Included in the list are the Ballard trunk sewer, reconstruction of the 15th Ave. North West bridge, extension of the trunk sewer system in the southeast section of the city, repair of the Cedar River pipe line Nos. 1 and 2, rearrangement of the Lake Washington sewer system and a further extension of Empire Way.

The Northfield Land & Water Co., Colorado Springs, Colo., has filed an application for a loan of $65,000 for waterworks improvements. The work proposed includes $50,000 for 23,000 ft. of 14-in. steel main, $5,000 for two new filter beds,

Wide World Photo

WATER-SUPPLY DAM FOR BRADFORD, ENGLAND, NEARS COMPLETION

The Scar House dam to impound water for the supply of Bradford, England, is here shown as the work approached completion. The dam is of concrete faced with granite and is 154 ft. high above the bed of the Nidd River. In the foreground of the illustration may be seen the tower for the sluice gates and the spillway channel.

and $10,000 for 6,500 ft. of 8-in. cast iron pipe. The company offers as security for the loan $85,000 of 5 per cent bonds, maturing in 1961.

Other projects in Colorado

A loan of $350,000 for the construction of a reservoir on the La Plata River in Colorado will be asked of the R.F.C. as soon as engineering plans can be completed. The reservoir is to aid settlers in the southwestern part of the state. It is stated that during dry years farmers in that section are unable to obtain sufficient water because of lack of storage facilities.

Another loan application from Colorado is contemplated for the construction of a tunnel under Independence Pass to divert water from Roaring Fork River to Twin Lakes and the head waters of the Arkansas River. The water will be used to irrigate land in Crowley county where there has been a drought for several years. The cost is estimated to be $3,000,000.

Clark County, Nev., will request a loan of $315,000 to be used for flood control in Virgin Valley, for flood control in Moapa Valley and for construction of lateral sewers in Las Vegas. The county will also request a loan of $35,000 for direct relief during the coming year.

The Columbia River Development League is urging the immediate start upon construction of the Grand Coulee dam, the initial phase of the Columbia Basin irrigation project through the cooperation of the state of Washington and the Reconstruction Finance Corporation. The league recommends obtaining a loan of $7,000,000 so that the work might be started.

The city council of Oklahoma City, Okla., is considering a $500,000 waterworks extension program, providing the funds can be obtained by a loan from the R.F.C. $300,000 will be required to extend the distribution system and $200,000 is for four overhead tanks.

The Regional Bridge Co., Kansas City, Kansas, has applied for a loan of $1,400,000 for the construction of a toll bridge over the Missouri River between Platte County, Mo., and Wyandotte County, Kansas.

Niles, Mich., by a vote of its city council, has decided to request an R.F.C. loan of $300,000 to finance the building of a sewage disposal plant.

Delaware bridge loan asked

An application for a loan of $39,000,000 has been filed by the Delaware River Joint Commission for the Philadelphia-Camden bridge. Of the loan, $8,000,000 will be used to construct a high-speed transit line across the bridge, $13,000,000 will go to New Jersey to retire Delaware River bridge bonds now held by the city. The state of Pennsylvania and the city of Philadelphia will receive $9,000,000 each, to retire bridge bonds.

City officials of Wellsville, Ohio, have announced that a request will be made for a $500,000 loan to construct a dam, filtration plant and hydroelectric plant on the Yellow Creek reservoir site.

The Kentucky State Highway Commission has called for bids on contracts that will utilize a portion of the $2,264,637 allotted to the state as part of the $120,000,000 emergency federal aid highway fund. The work advertised will include surfacing of 75.6 miles of roadway. Bids were received on Aug. 10 for 53.8 miles of roadway and for the surfacing of 42.15 miles. The total estimated cost of the improvements advertised in the August lettings is about $1,750,000.

Niagara Falls Promises to Build Docks if Channel Is Deepened

Deepening of the Niagara River at Niagara Falls, N. Y., at a cost of $750,000 is expected to advance beyond the plan stage with the assurance given recently by the city council of Niagara Falls to the War Department that it will provide adequate dock and terminal facilities. Plans for the project call for the deepening of the east channel of the river from Tonawanda to Niagara Falls to a depth of 12 ft. so that barges and small freighters may bring their cargoes to Niagara Falls. Money has been appropriated by Congress for this purpose but the work delayed pending assurance of adequate terminal facilities by the city.

Falling Marquee Kills Two on New Orleans Sidewalk

Sudden collapse of a heavy marquee over a sidewalk along Canal Street in New Orleans killed two people and injured many others on August 7. The marquee was on the front of the Audubon Building. It was of steel, glass and reinforced concrete, supported at the wall at the first floor level and by suspenders extending from the outer edge to the building wall at the second floor level. Collapse of the entire 90-ft. length was practically instantaneous, according to eye witnesses. The suspenders tore loose from the marquee at their outer end at all six points of support.

Since the collapse of this marquee the city has made an examination of other similar structures throughout the city and in two instances owners have been ordered to dismantle them.

Denver Urges Start of Work on the Dotsero Cutoff

The city and county of Denver have formally petitioned the Interstate Commerce Commission to authorize the Denver & Rio Grande Western Ry. to proceed with the construction of the Dotsero Cutoff under the plan now before it. Recently the railroad company made application to the Reconstruction Finance Corp. for a loan of $4,000,000 to finance construction of the cutoff. Loans from the R.F.C. to railroad companies require approval of the Interstate Commerce Commission.

The cutoff will require the construction of about 42 miles of railroad to connect the Denver & Salt Lake Ry. west of the Moffat Tunnel with the Denver & Rio Grande Western main line southwest of Denver. The cost is estimated at $3,500,000.

Court proceedings to prevent construction of the cutoff are being continued. A judgment rendered recently in the U. S. District Court for the District of Delaware in the case of the Moffat Tunnel League and others against the United States and others is to be appealed to the U. S. Supreme Court. The suit is to enjoin an order of the Interstate Commerce Commission authorizing the D.&R.G.W. Ry. to acquire control by stock purchase of the Denver & Salt Lake Ry.

Engineering Board Named by R.F.C. Takes Up Its Work

Washington Correspondence

RAPID progress is being made by the engineering board of the Reconstruction Finance Corporation in organizing its staff and in familiarizing itself with pending applications.

A last mintue change in the list of engineers comprising the advisory board resulted in Major General Lytle Brown being made an actual member of the board rather than an ex-officio member. In order to do this it was necessary to eliminate H. G. Moulton from the list which had been selected for membership on the board. It was pointed out that Mr. Moulton, who already is a member of the staff of the Reconstruction Finance Corporation, would be able to devote just as much of his time as is necessary to the work of the board without actually being included in its membership.

Due to the pressure on the directors of the Reconstruction Finance Corporation to pass upon an accumulation of applications under the old act, little opportunity had been given for the consideration of construction projects. The board also felt that it could not act on these projects without engineering advice, particularly as every application was inadequately supported by documents to sustain the request.

With the appointment of the engineering board an immediate effort was made to classify the applications. Enough information has been furnished in certain cases to indicate that they are particularly promising, but even in those instances no single application had been received, at the time of this writing, which can be acted upon without requesting additional data. It is pointed out that when applicants for a large commercial loan go to a private financial agency for support they would not expect the banker to act until complete supporting data had been prepared. It is recognized that Uncle Sam at this time is more than anxious to loan this money, as contrasted with the private banker who usually, in the beginning, is unwilling to make the loan and has to be persuaded by sheer facts and information to reverse his position. The board of engineers apparently feels that its responsibility to the government is exactly what it would be to a private financial agency that had retained its services. Moreover, the members feel that they have a responsibility to the engineering profession and that they must do a particularly thorough job in protecting the government from unsound schemes and unprofitable loans.

The board is determined that it will not be meticulous in the consideration of projects. It would rather make an occasional mistake and get something done than to guard against any possible mistake and greatly delay the program.

While the board is being handicapped greatly by the incomplete character of applications before it, it has picked out nearly 100 projects that are better supported by necessary facts than are the others and are concentrating on getting in the remaining essential information. The members are confident that the results of their work soon will begin to show.

Large Housing Project Planned for New York Metropolitan Area

Plans for a $20,000,000 housing development in the Borough of Queens, New York City, have been filed with the State Board of Housing by Samuel Rosoff, subway contractor. The property which Mr. Rosoff proposes to develop with a group of multi-family houses, eventually to accommodate 1,500 families, is a tract of about 66 acres which he acquired for the disposal of material excavated from the subway which he built in Queens.

New Highway Bridge to Be Built Over St. Lawrence at Montreal

Bids for the construction of a new highway bridge over the St. Lawrence river, to link the island of Montreal, near Lachine, with Caughnawaga on the mainland to the south, are to be asked shortly, according to an announcement by Premier Taschereau of Quebec. The bridge which is estimated to cost $3,000,000, will be a provincial undertaking, and will be built by the Lake St. Louis Bridge Commission.

Plans for the new bridge have been completed for some time. The site will be downstream from the existing Canadian Pacific Ry. bridge, and a connection will be made with the highway running to Malone, N. Y. Tolls will be charged on the bridge, which is expected in course of time to become self supporting. The new bridge will be the third to carry private vehicles and will obviate the necessity of either crossing by ferry between Lachine and Caughnawaga or taking the much longer route between the latter place and the Victoria bridge from Montreal to St. Lambert.

Hoover Dam Notes

Present plans contemplate diverting the Colorado River at Hoover dam through the two Arizona tunnels, No. 3 and No. 4, the latter part of October. The two tunnels can handle the normal river flow. Tunnel No. 2 on the Nevada side will be ready soon afterwards. The first concrete lining placed in tunnel No. 1 was made Aug. 3 with an invert pour. Drilling of low-pressure grout holes was started in tunnel No. 2 on Aug. 5.

* * *

The discharge of the Colorado River increased from 15,600 c.f.s. on July 31 to 21,400 c.f.s. on August 6. Maximum temperatures rose during the week ended August 6 and reached 117 degrees in the canyon and 109 degrees in Boulder City. Minimum temperatures were 84 degrees and 77 degrees, respectively. Those employed on the project and by private enterprise in Boulder City at the end of the week under review totalled 3,640 persons.

* * *

Studies are being made of the final excavation lines for the foundation and abutments of the dam. Designs for the intake towers and for the bridges to these towers are under preparation. The draft of specifications for the permanent cableway has been completed. Further study is being given the question of electric traveling cranes for the power plant.

Frederick B. Brown, Canadian Engineer, Accidentally Killed

Frederick B. Brown, consulting engineer, Montreal, was accidentally killed at his summer home at Lac Ouareau by being struck with the propeller blade of a seaplane which had just alighted on the beach of his cottage. Mr. Brown was a native of Montreal and a graduate of McGill University in 1903. From 1905 to 1910 he was with the engineering firm of Ross & Holgate and in 1910 became a partner in the firm of Walter J. Francis & Co. Upon the death of Mr. Francis in 1924 he became head of the firm. Recently Mr. Brown has practiced under his own name. He has specialized largely in hydro-electric power development, power transmission and hydraulics.

Highway Departments Set Rates For Work Under Relief Act

Failure of representatives of the Bureau of Public Roads and of the state highway department of Colorado to agree on the minimum wage to be paid to common labor on Federal-aid work in that state has resulted in an appeal to the bureau's headquarters in Washington for a ruling. The engineering representative of the Bureau of Public Roads has set 50 cents an hour as the minimum to be paid while the highway department maintains that with the shorter hours required under the Emergency Relief and Construction Act this is not a living wage and that the minimum should be set at 60 cents.

On the point in question the relief act, in providing $120,000,000 for additional highway work, states that "all contracts involving an expenditure of money under the act shall contain provision establishing minimum rates of wages, to be predetermined by the state highway department, contractors shall pay the skilled and unskilled labor, and such minimum rates shall be stated in the invitation for bids and shall be included in proposals or bids for the work."

In Louisiana the highway commission, in calling for bids to be opened on September 7 for 35.6 miles of highway has set a minimum wage scale of 20 cents per hour for a 30-hour week. In Ohio the rate for unskilled labor has been set at from 35 to 50 cents per hour for a 30-hour week and for skilled labor, including operators of concrete mixing machines and superintendents, up to 50 per cent more than the rate paid unskilled labor. Notification to the bidders in Ohio reads: "Teams, trucks and hand power—power grading equipment not permitted." This latter provision is in line with the regulation put out by the Bureau of Public Roads recently. (*ENR* Aug. 4, 1932, p. 142.)

The State Highway Department in Virginia has set a minimum hourly rate of 20 cents for unskilled labor. This is an increase of 5 cents over the rate which has been paid in recent months.

The Maryland State Roads Commission has set minimum wage scales for skilled and unskilled laborers employed by contractors on state roads work. It also set 10 hours as a maximum working day on all road work. Unskilled

labor on the Eastern Shore and on the Western Shore south of Annapolis will receive a minimum of 25 cents an hour. In other parts of the state the minimum will be 35 cents. The difference was made because of the difference in the cost of living in the various parts of Maryland. Truck and tractor drivers and teamsters will receive 25 per cent more than the minimum wage and other skilled workers 50 per cent more.

Court Decides Suit Over Piles in Favor of Dock Board

Decision for the defendant has been handed down by the U. S. District Court, Judge Thomas F. Porter sitting, in the suit brought by the contractors P. Olivier & Sons against the dock board of Lake Charles, La., which took over a contract for wharf construction upon discovery of defective piles and upon refusal of the contractor to replace them. Briefly the decision was: that the plaintiff's claims against all defendants be rejected; that the temporary injunction issued be set aside; that the dock board's rights against the plaintiff and its surety, arising out of the contract in question and bond, as well as from the issuance of the temporary injunction, be reserved to the dock board, and that the plaintiff pay all costs of this suit, including the fees of the three experts, which, with the consent of the parties, are approved and taxed as costs.

Substantially the occasion and procedure of the litigation were as follows: In the contract held by the Olivier company for building a wharf unit and wharf sheds and houses, some 1,500 or more treated piles had been driven without suspicion on the part of anybody that anything was wrong with them. Dredging operations on a small scale immediately in front of the wharf caused one or two of the piles to fall over, and when these were withdrawn, it was discovered that from 15 to 25 ft. of the length of the piles had the wood fibers so completely separated that they looked like old worn hemp rope. As a result of this discovery, a number of piles were pulled within the wharf structure, and something like 80 per cent of those which were so pulled showed the same condition. The port commissioners after careful consideration and advice rejected the entire structure and the materials which had been delivered for its completion.

The specifications under which the treating had been done were standard specifications under which hundreds of thousands of other piles had been treated for other users all over the country, and there had never been any report of any failure which might be compared either in nature or extent with the failure at Lake Charles. During the course of the trial, it was disclosed that in the latter two hours of the steaming period in the treatment which had been at a 30 lb. pressure, compressed air had been introduced into the treating cylinder to such an extent that the combined pressure of steam and compressed air ranged from 70 to 90 lb. So far as has been disclosed, this was the only variation from practice at other points either in treating or in driving.

The port commission claimed, and all of its witnesses testified, that this introduction of compressed air was a violation of the specifications, while the company which treated the material claimed such treatment was not prohibited by the specifications. The court held that there had been a breach of specifications and on this holding based the decision recorded. It did not rule as to the cause of the failure of the piles. On the latter point the expert witnesses disagreed.

SOCIETY CALENDAR

AMERICAN ASSOCIATION OF ENGINEERS, annual convention, Washington, D. C., Sept. 26-28.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual meeting, Washington, D. C., Nov. 14-18.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, annual meeting, White Sulphur Springs, W. Va., Oct. 11-14 (tentative).

AMERICAN PUBLIC HEALTH ASSOCIATION, annual meeting, Washington, D. C., Oct. 24-27.

AMERICAN RAILWAY BRIDGE & BUILDING ASSOCIATION, annual meeting, Toronto, Ont., Canada, Oct. 18-20.

AMERICAN SOCIETY OF CIVIL ENGINEERS, fall meeting, Atlantic City, N. J., Oct. 5-8.

AMERICAN SOCIETY OF MUNICIPAL ENGINEERS, annual meeting, New Orleans, La., Nov. 14-18.

AMERICAN WELDING SOCIETY, fall meeting, Oct. 3-7, Buffalo, N. Y.

ASPHALT INSTITUTE, Asphalt Paving Conference, New Orleans, La., Dec. 5-9. The ASSOCIATION OF ASPHALT PAVING TECHNOLOGISTS will meet in conjunction with the paving conference.

INTERNATIONAL ASSOCIATION OF PUBLIC WORKS OFFICIALS, annual conference, Pittsburgh, Pa., Sept. 29-Oct. 1.

INTERNATIONAL CITY MANAGERS ASSOCIATION and GOVERNMENTAL RESEARCH ASSOCIATION will hold a joint annual conference at Cincinnati, Ohio, on October 24 to 26.

NATIONAL ASSOCIATION OF RAILROAD AND UTILITIES COMMISSIONERS, annual meeting, Hot Springs, Ark., Nov. 15-18.

NATIONAL COUNCIL OF STATE BOARDS OF ENGINEERING EXAMINERS, annual meeting, New York City, Sept. 29-Oct. 1.

NATIONAL SAFETY COUNCIL, annual congress, Washington, D. C., Oct. 3-7.

NEW ENGLAND WATER WORKS ASSOCIATION, annual meeting, Springfield, Mass., September 27-30.

Road Bond Issue Up in Oklahoma

A proposal to issue $15,000,000 of state bonds for highway work as an aid to unemployment in Oklahoma has received sufficient signatures for it to be placed on the ballot for the general election in November. Opponents of the proposal plan court action to check it.

Washington to Increase Water Storage

Increase of Washington's water storage by 345,000,000 gal. is called for in plans under consideration by the Secretary of War and Chief of the Army Engineer Corps. The last Congress appropriated $150,000 for the construction of a dam at the west end of the present Dalecarlia Reservoir. The total storage when the new dam is completed will be equal to five days' supply.

Personal Notes

CLARENCE S. RIDLEY, lieutenant colonel, Corps of Engineers, U. S. Army, now attached to the Army Industrial College, Washington, D. C., has been assigned to duty in the Panama Canal Zone.

P. D. FITZPATRICK, assistant chief engineer, Canadian National Rys. in charge of the Montreal Terminals development, has been appointed chief engineer of the Grand Trunk Western Ry., a subsidiary of the Canadian National Rys., with headquarters at Detroit, Mich. Work on the Montreal terminal has been largely shut down.

GEORGE E. HAVENS has been appointed Yates County, N. Y., superintendent of highways to succeed the late Matthew McEvoy. Mr. Havens has been acting superintendent since Mr. McEvoy's death.

RANSOM ROGERS, assistant county highway engineer, of Fulton County (Atlanta), Ga., was appointed highway engineer on July 19 to succeed the late H. N. Hurt.

GEORGE W. LITTLEHALES, chief of the division of research of the hydrographic office of the Navy Department, was retired on August 1 under the provisions of the economy bill after 47 years of service. He is a graduate of George Washington University in civil engineering in 1888.

WALTER E. SULLIVAN, chief engineer of sewers for the city of Cincinnati, Ohio, retired July 30 and will engage in private practice as a consulting engineer. He had held the position since Oct. 1, 1914, and before that had served as an assistant city engineer and as assistant waterworks superintendent.

Obituary

JOHN W. ATKINSON, former city engineer of Galion, Ohio, died there on Aug. 10, age 75 years.

B. L. KIRKEBO, contractor, Kokomo, Wash., died there recently. Mr. Kirkebo formerly was associated with the J. E. Bonnell Co. in the construction of Camp Lewis in 1917.

HUGH A. BROWN, director of reclamation economics, Bureau of Reclamation, Washington, D. C., died suddenly of a heart attack in that city on Aug. 13. Dr. Brown has been associated with the department for twenty years.

FRANK PETRY, metropolitan sales manager, Pennsylvania Dixie Cement Corp., died suddenly at Hackensack, N. J., August 8, age 46. Mr. Petry has been active in the construction field in cement operations for the past 21 years.

WALTER KEITH BROWNELL, chief of the structural engineering division, United Engineers & Constructors, Inc., died at Philadelphia on Aug. 9, age 44 years. Mr. Brownell was a graduate of Massachusetts Institute of Technology in the class of 1910, was with Stone & Webster Engineering Corp. for six years prior to the war, and after two years of service with the American International Shipbuilding Corp. in Philadelphia 1918-1919, entered

the employ of Dwight P. Robinson & Co. of New York as head of the structural engineering division. When this company merged with the other companies forming the United Engineers & Constructors, Mr. Brownell was made head of the same division in the new organization.

REINHOLD KROHN, one of the leaders of steel bridge construction in Germany, died at Danzig on June 29 at the age of 79. From 1886 to 1904 he was head of the Sterkrade bridge works of the Gutehoffnungshütte, and in this period achieved note particularly through his introduction of long-span tied arches, including the Rhine bridge at Bonn, for a time the longest arch span in the world. He also contributed to the adoption of steel in place of wrought iron for bridge work. During the past quarter century he was professor at the Danzig Technical College.

Engineering Contracts and Capital

HEAVY engineering construction contracts reported for the past week total $14,751,000, the lowest weekly figure in two months. The previous week's contracts were $21,858,000, and awards totaled $28,166,000 for the first week of the month. That the low figure of the past week represents but a lull in late summer construction activities is indicated by a heavy list of proposed work called for early bidding. The record of the past week is also unusual in that it does not contain a single contract in excess of $1,000,000. A considerable falling off in federal awards was noticed.

New capital issues for the past week reached a total of $28,000,000, about three-fourths of which represents private issues. The weekly average of new capital for August exceeds the average of the month for last year.

New York Highway Progress—Highway paving to date this year in New York state totals 231.35 miles. At present 155 contracts are under way, on which 7,550 men are employed. The state maintenance force totals 5,507 at present. Highway construction employment in July increased 17 per cent over that of June.

Ohio Employment Increases—According to the Bureau of Business Research of Ohio State University, employment in street, road and sewer construction showed an increase of 10 per cent in July over that for June. Total employment for the first seven months of the year was 10 per cent above that for the same period last year.

General Employment Decreasing—Reports of the American Federation of Labor indicate a steady increase in unemployment, with 600,000 persons thrown out of work since June, when 11,023,000 idle workers were reported. At the present rate of increase in unemployment, the total of 13,000,000 will be reached by January, according to the Federation.

Virginia Sets Minimum Scales—Highway contractors will be required to pay not less than 20c. per hour for common labor on work done in Virginia under the federal highway loan provisions, according to Governor Pollard. This scale has already been attacked in certain sections, resulting in promises of a 25-cent minimum in some counties.

Thirty-Hour Week Urged in Maryland—A 30-hour week in all state and municipal departments and on all construction work carried out by the state and municipalities of Maryland was advocated recently by the Baltimore Federation of Labor.

Relief Work in Milwaukee—Milwaukee will be able to provide work for 8,000 jobless on ten-day shifts out of funds donated by city employees. The donation of 10 per cent of salaries by municipal employees has created a fund of $800,000 for relief work.

Lumber Stocks Too High—The special lumber survey committee of the U. S. Timber Conservation Board reports that its previous recommendations have resulted in a reduction of more than 4 billion feet of surplus stocks since the late 1930 peak, but further reduction is needed in view of the abnormal falling off in demand. The present demand is indicated at the rate of 12.4 billion feet annually, as compared with a yearly demand of 35.5 billion feet in 1929. Specific recommendations as to means of further reduction in stocks include avoiding unnecessary production of items already in surplus, and the pooling and exchange of stocks and consolidation of sales. Present price levels threaten industry insolvency and soundness of individual firms, the committee reports. The anticipated lumber demand for the third quarter of the year is 2.8 billion feet, about half of which will be required by the construction industry.

Contracts and Capital

CONSTRUCTION
(Thousands of Dollars)

	Weekly Aug., 1931	Average Aug., 1932	Week Aug. 18 1932
Federal government	$2,710	$4,689	$1,806
State and municipal	17,904	12,777	9,353
Total public	$20,614	$17,466	$11,159
Total private	16,612	4,126	3,592
Week's total	$37,226	$21,592	$14,751
Cumulative, Jan. 1 to date:			
1931 construction			$1,750,935
1932			780,564

Decrease, 56 per cent.

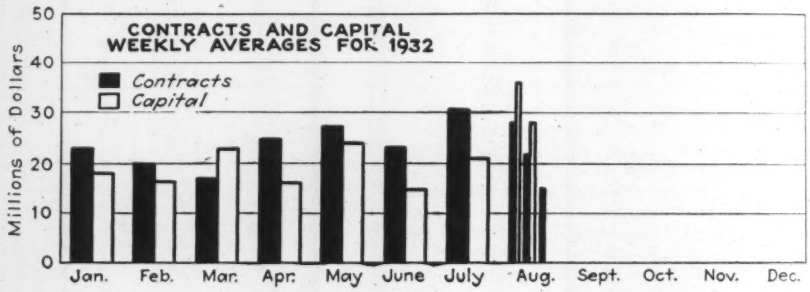
NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

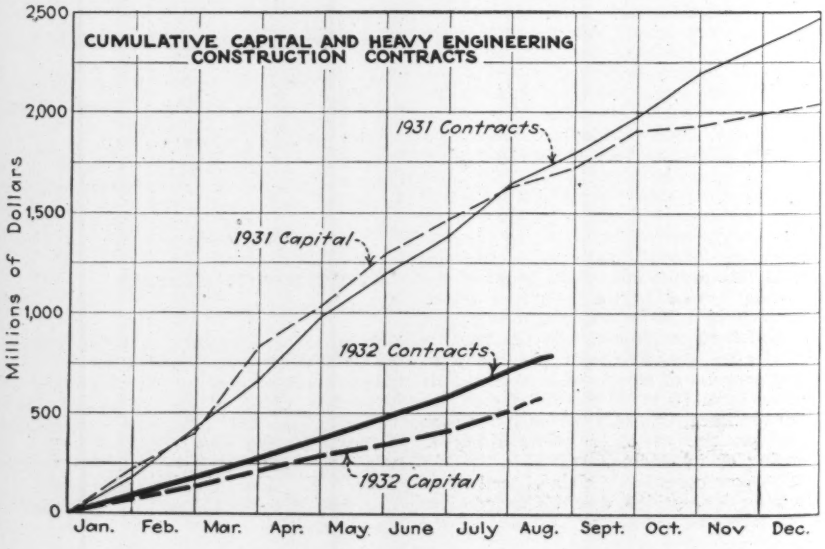
	Weekly Aug., 1931	Average July, 1932	Week Aug. 6 1932
Total private and public	$21,000	$32,000	$28,000
Cumulative, Jan. 1 to date:			
1931 new capital			$1,673,000
1932 new capital			581,000

Decrease 65 per cent.

ENR Cost and Volume Index

Cost		Volume	
August, 1932	**156.80**	**July, 1932**	**166**
July, 1932	153.36	June 1932	131
August, 1931	171.38	July, 1931	248
1931 (Average)	181.35	1931 (Average)	220
1930 (Average)	202.85	1930 (Average)	260
1913 Average	100.00		

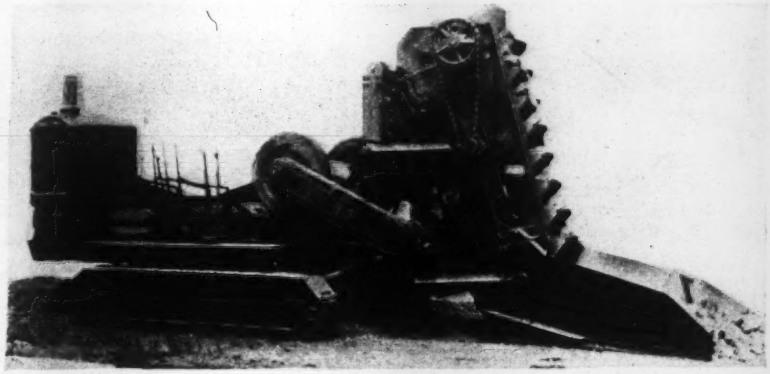




Construction Equipment and Materials

New Road-Working Machine Crushes and Screens Gravel

A new road-working machine that picks up gravel from a windrow, elevates it, crushes and screens and returns it to the road has been developed by the Rogers Iron Works Co., Joplin, Mo. The machine is a self-contained, self-propelled and self-feeding unit, built in either crawler or wheel type. After the material has been picked up by the loader it is elevated and delivered to the crusher for reduction, which discharges onto a shaker screen. The undersize product of the screen drops to the road. The oversize material is passed forward into the boot of the loader, from which it is again picked up, elevated and crushed. A conveyor is mounted beneath the screen discharge and extends to the rear. In operation, the material from the screen falls on the conveyor belt and is discharged into a bucket elevator at the rear of the machine. The elevator is of the proper height to permit stockpiling or loading in trucks.

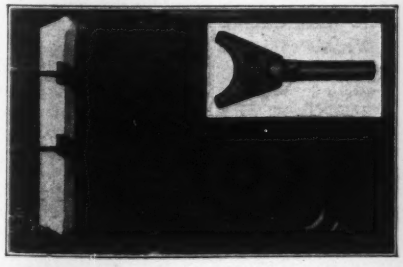


New machine crushes and screens road gravel.

Highway Guard-Rail Fittings

A new line of malleable iron fittings for highway guard-rails has been brought out by Joseph H. Ramsey, 11 N. Pearl St., Albany, N. Y. A device for securing the cables to the anchor rods at the end of the span is shown in the accompanying illustration. A sleeve or quill is internally threaded at its lower end to receive the threaded upper part of an anchor rod. A circular external flange on the upper end of the sleeve is freely held within a recess in the frame. The frame has a semi-circular inner surface for free engagement with the looped end of the guard-rail cable. The device equalizes the strain of a collision upon both cables.

Fitting for end spans of guard-rails.



New Publications

Arc Welding—The Lincoln Electric Co., Cleveland, Ohio, manufacturers of "Linc-Weld" motors and "Stable-Arc" welders, have just published a new 24-page bulletin known as Section No. 3304, covering a complete line of supplies for arc welding. A full description with prices of electrode holders, cables, protective shields, protective lenses, protective clothing and various supply parts is included in the bulletin. Among the new electrodes described is "Manganweld" for welding high manganese steel, "Aluminweld" for welding aluminum and "Hardweld" for hard or abrasion-resisting welds. "Fleetweld," a shielded arc electrode for mild steel, is also discussed. The bulletin is for general distribution, and copies may be secured from the company.

Air Filters—The Coppus Engineering Corp., 344 Park Ave., Worcester, Mass., has issued bulletin F-310, describing the Annis air filters for air compressors and internal combustion engines. The filter element consists of a special all-wool felt that fits glove-like on a wire spacer frame. The filter proper is made up of a number of these elements and is covered by a heavy sheet-metal protection. In use the filter is placed so that the vacuum is on the interior of the filter elements. At intervals depending on use and dust concentration, the elements can be cleaned in place by blowing off the dirt with a compressed-air lance or by the use of a vacuum cleaner. When renewal becomes necessary, it is accomplished by the replacement of the felt filter element.

Business Notes

WILLIAM B. POLLOCK CO., Youngstown, Ohio, announces the establishment of a special engineering department to design shop equipment for welded rolled-steel fabrication. The company has had 69 years of experience fabricating heavy equipment for steel mills, blast furnaces, refineries and other basic industries. For the past ten years the company has studied the possibilities of welded fabrication.

INLAND STEEL CO., Chicago, announces the opening of offices at Detroit, Mich., and the appointment of J. H. Fitch, Jr., as district sales manager of this office. This marks the Inland Co.'s first entry into the Detroit area during the last ten years and is directly related to the recent installation and completion of a large continuous-strip sheet mill, which produces auto-body sheets and various other strip and sheet products used in the automotive industry.

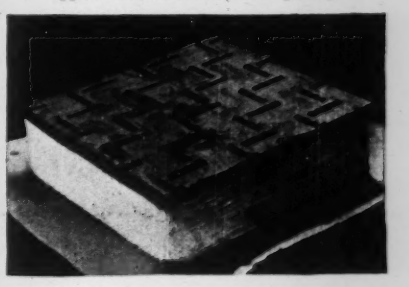
STEPHENS-ADAMSON MFG. CO. OF CANADA, Belleville, Ont., has concluded an arrangement with the Orton Crane & Shovel Co., of Huntington, Ind., for the manufacture and sale in Canada of Orton locomotive cranes, dipper shovels, pullback ditchers, skimmers, clamshell buckets, orange-peel buckets, traveling gantry and cantilever cranes and similar equipment. This equipment will be known as the Saco-Orton line.

NATIONAL CONSUMERS PAPER CORP., New York, N. Y., has established a department for the manufacture of drawing, tracing and detail papers, to be under the direction of John R. Cassell. Mr. Cassell has been associated with the Charles Bruning Co. for the past ten years.

Cast-Iron Paving Blocks

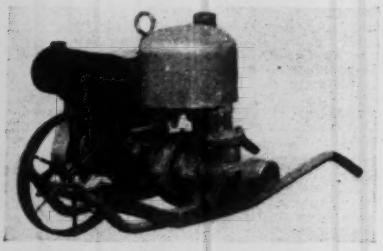
A cast-iron plate for paving concrete roadways is being introduced by the Ippen Steel Manufacturing Co., Hradec Kralove, Czechoslovakia. The manufacturer claims that the plate will not crack under the heaviest load and that the special alloy used in its manufacture practically eliminates wear. The metal is also non-corroding. The plate is about ¾ in. thick and is anchored deeply into the concrete. The surface can be given any pattern desired. Plates come either 15 in. square or triangular.

Ippen Steel Co.'s cast-iron paving.



Self-Priming Centrifugal Pump

The Chain Belt Co., Milwaukee, announces a new 2½-in. self-priming centrifugal pump. The new unit is of the recirculating type and is automatic in action after the recirculating system has been filled. The manufacturer states that factory tests show that the pump meets the



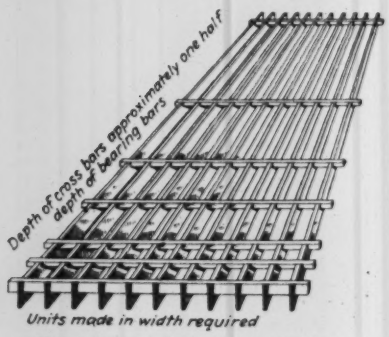
Chain Belt self-priming pump on wheelbarrow frame.

A.G.C. 2½-in. pump rating of 12,000 gal. per hour on a 10-ft. suction lift and also meets the maximum lift rating of 25 ft. The new unit weighs 305 lb., is 28 in. high and 36 in. wide.

It is claimed that the self-priming system allows the pump to pick up its prime on a 15-ft. suction lift in less than 1 min. The impeller is of the open-trash type with two blades. Power is supplied by a compact air-cooled engine. Pump and engine are mounted together on a wheelbarrow frame.

New Grating of Tapered Bars

A new type of self-cleaning, non-clogging, rolled-steel grating and armoring has been introduced by the Belmont Iron Works, Philadelphia, Pa. The bars of which the grating is made are tapered, leaving a wider space below than above, so that any material that passes through

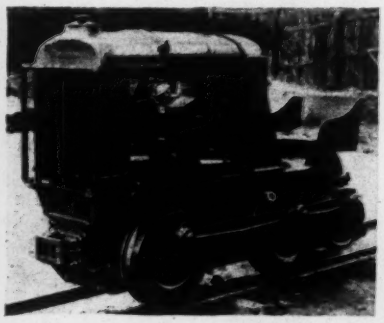


Tapered-bar grating is non-clogging.

at the top will continue unhindered. When filled with concrete or mastic material and used as armoring, the tapered or splayed sides of the bars form a positive bond and anchor for the filling material.

Small-Clearance Locomotive

A new gasoline locomotive, for use in mines where good ventilation is available, is announced by the Ruth Co., Denver, Colo. It is designed to operate on 18-in. gage track. The width of the locomotive is 31½ in., or 13½ in. narrower than the common industrial type locomotive. The height is 4 ft. 4 in. The radiator has a capacity of 10 gal. The narrow width and a low center of gravity are made possible by the side-rod drive. The locomotive is built in sizes of 2, 2½, 3, 3½, 4 and 5 tons.



Ruth mine locomotive.

Car-Mounted Compressor

An air compressor that will economically serve the railroad industry is being announced by Schramm, Inc., West Chester, Pa. A standard Schramm compressor, containing all construction features that the portable compressor embodies, is mounted on a substantial rail car. The same engine that drives the compressor unit propels the outfit by means of a heavy chain drive. A clutch feature enables the operator to disconnect the compressor from the engine.

Schramm compressor for railroad work.

New Equipment in Brief

Pipe-Threading Machine—A new motor-driven portable pipe-threading machine has been placed on the market by the Oster Manufacturing Co., 2067 East 61st Place, Cleveland, Ohio. The manufacturer's designation of the machine is No. 512 Tom Thumb. The regular pipe capacity includes all sizes from ½ to 2 in., with an extra capacity down to ¼ in.

Six-Wheel Truck—A six-wheel 8-ton truck has been announced by the Federal Motor Truck Co., Detroit, Mich. The driving axle is placed at the rear with the dead axle ahead, providing increased traction to the driving wheels. The truck carries a gross rating of 28,000 lb. Power is provided by an 80-hp. six-cylinder engine.

Aggregate Scale—A contractors' aggregate weighing scale is being manufactured by the Best Scale Co., Pittsburgh, Pa. The platform is 40 in. long and 38 in. wide. The scale frame is 6¼ in. deep. The scale is furnished with as many beams as required, eight if necessary. The weigh beams are of an aluminum alloy. Bearings and knife edges are stellite metal backed with a low carbon steel.

Forced-Feed Faucet — The LeMay forced-feed faucet for extracting plastic compounds, cement and other slow-flowing mixtures from bulk containers is being introduced by the Key Boiler Equipment Co., East St. Louis, Ill. It is adapted for use on drums equipped with standard 1½-in. pipe openings. A crank-driven worm provides a smooth even flow and keeps the material mixed to the proper consistency.

Electrode Holder Stand—A new welding electrode holder stand, which automatically shuts down the welder one minute after the holder is placed on the stand and starts the welder when the holder is removed, is announced by the Lincoln Electric Co., Cleveland, Ohio. When the hook is depressed by the weight of the holder, it actuates a special timing device which, at the end of one minute, disconnects the welder from the power supply line. When the holder is removed from the hook, the welder starts automatically. The holder hook can be adjusted in height to suit the convenience of the operator.

Vibrator Screen—A new vibrator screen is announced by the Stephens-Adamson Manufacturing Co., Aurora, Ill. The screen is of the positive vibration type, in which a rigid screen body with one or more decks is given a vibration of fixed amplitude by the rapid throw of an eccentric shaft. There are three units, screen body, vibrating mechanism and subframe. The vibrating mechanism is a self-contained, factory-adjusted unit.

Transite Pipe—Johns Manville, New York City, is manufacturing pipe made of Transite, a material composed of asbestos fiber and portland cement combined under pressure. The pipe is manufactured in seven classes of varying pressure requirements, ranging up to pressures equivalent to 500 ft. of water. The pipe material is highly resistant to external and internal corrosion, tuberculation, electrolysis and the reaction of many chemicals. It weighs 125 lb. per cubic foot.

Gasoline Engine — The Continental Motors Corp. has just announced a new model four-cylinder engine of 74.83-cu.in. displacement for industrial application. The engine is of 2-in. bore and 3 5/32-in. stroke. It develops 10.75 hp. at 1,200 r.p.m., the recommended governed speed, and 17.8 hp. at 2,000 r.p.m. The complete power unit, including carburetor, magneto, governor, fan, radiator, gasoline tank, controls, etc., weighs 350 lb.

New Explosives—A series of explosives of a new type, known as "Red Cross Blasting Nos. 2, 3 and 4 F. R.," has been developed by the explosives department of E. I. du Pont de Nemours & Co., Wilmington, Del. These so-called free-running powders actually are dynamite of special grades in loose form. They are particularly designed for use in sprung holes. Detonation by means of an electric blasting cap is recommended.